

A Guide to Thinking

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A GUIDE TO THINKING

A Guide to Thinking

A Beginner's Book in Logic

By

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and

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PREFACE

THESE pages are the result of an effort to teach logic to young people having little or no training in philosophical studies. The discussion is confessedly as simple, in both matter and form, as the writers have been able to make it.

A threefold purpose has directed the preparation of the manuscript, namely:

First, to make apparent the incalculable importance of right thinking in everyday life;

Second, to provide the essentials of an elementary course of training in correct thinking; and

Third, to encourage those who feel the need of greater skill in thinking to continue faithfully in the effort to acquire it.

LAWRENCE, KANSAS

January 3, 1927

O. T.

A. M.

CONTENTS

PART I—KNOWLEDGE

CHAPTER	PAGE
I. Introduction	1
II. Knowledge	5

PART II—MATERIALS OF THINKING

III. Ideas and Terms	27
IV. Judgments and Propositions	49
V. Types of Judgments and Propositions	68
VI. Trains of Thought and Discussions	85

PART III—METHODS OF THINKING

VII. Observation; Analysis; Synthesis	101
VIII. Cause and Effect	111
IX. Immediate Inference.	134
X. Mediate Inference—Analogy and Induction	150
XI. Mediate Inference—Deduction.	161
XII. Deduction — Forms of Deduction (continued)	181
XIII. Probability	199

**PART IV—THE PATHOLOGY OF THINKING
AND RESULTS OF THINKING**

CHAPTER	PAGE
XIV. The Pathology of Thinking	209
XV. Results of Thinking	220 236
XVI. Conclusion	244
Index	249

OUTLINE

KNOWLEDGE

NATURE OF KNOWLEDGE

KNOWLEDGE CONCERNED WITH

Facts

Principles

USE AND NEED OF KNOWLEDGE

TYPES OF KNOWLEDGE

Suggestion

Opinion

Conviction

Proved Knowledge

Axiomatic Knowledge

PREFERENCE AND PREJUDICE

SOURCES OF KNOWLEDGE

Tradition

Current Report

Testimony of Other Persons

Telepathy, Intuition, Inspiration, Hunch

Individual Perception

Thinking

MATERIALS OF THINKING

IDEAS AND TERMS

Nature of

Ambiguity of Terms

Abstract and Concrete Terms

Denotation and Connotation

Division and Classification

Rules of Division

Definition of Terms

JUDGMENTS AND PROPOSITIONS

Nature of

Normal Form of

Truthfulness of

Field of Application of

Distribution of the Terms of

Quality of

Affirmative

Negative

Quantity of

Universal

Partial (Particular)

Types of Judgments and Propositions

Categorical

Alternative

Hypothetical

Reduction of Propositions to Normal Form

TRAINS OF THOUGHT AND DISCUSSIONS

Nature of

Logical Trains of Thought

Types of Trains of Thought

Reverie

Rationalization

Problematic Thinking

Creative Thinking

Community of Thinking

Training in Thinking

METHODS OF THINKING

OBSERVATION

Nature of

Necessity of

Skill in

Imagination Required in

Prejudice and Its Effect

Scientific Instruments an Aid to

ANALYSIS AND SYNTHESIS

Analysis

Synthesis

Contrast of Analysis and Synthesis

CAUSE AND EFFECT

Nature of

Kinds of Effects

Events

Continua

Kinds of Causes

Antecedent to Effect

Concomitant with Effect

Means of Determining Causes and Effects

Observation, Analysis, Synthesis

Hypothesis

Experimentation

Nature of

Difficulty of Experimentation in

Experimentation in Science

Conclusive Experiments

Methods of Determining Causes and Effects

Method of Antecedent and Consequent

Method of Concomitant Variation

Results of Determining Causes and Effects
Knowledge of Facts
Knowledge of Principles
Natural Law

INFERENCE

Nature of

Immediate Inference

Conversion of Categorical Propositions

Obversion of Categorical Propositions

Inter-relation of Categorical Propositions

Mediate Inference

Analogical Reasoning

Nature of

Presupposition in

Induction

Nature of

Forms of

Induction by Enumeration

Induction by Essential Characteristics

Deduction

Nature of

Comparison with Induction

Uses of

Forms of

Enthymemes

First Order

Second Order

Third Order

Syllogisms

Nature of

Types of

Alternative Syllogisms
 Hypothetical Syllogisms
 Dilemmas
 Simple Constructive
 Simple Destructive
 Complex Constructive
 Complex Destructive
 Categorical Syllogisms
 Moods
 Figures

PROBABILITY

PATHOLOGY OF THINKING

Innate Stupidity
 Intellectual Indifference
 Preference of Accepted Beliefs
 Emotional Disturbance
 Personal Coefficient
 Intellectual Mendacity
 Ignorance of Logical Principles
 Excessive Confidence in the Simplicity of the
 Universe
 Excessive Confidence in the Applicability of Theory
 Obscurity of Diction
 Ambiguity of Diction
 Diversity of Purpose or Changing the Issue
 Argumentum ad Hominem
 Argumentum ad Populum
 Argumentum ad Ignorantiam
 Argumentum ad Baculum
 Fallacies in Division and Classification

Fallacy in Definition
Fallacious Conversion
Bad Observation
Hasty Induction
False Analogy
False Cause
Assuming the Conclusion
Affirming the Consequent or Denying the Antecedent
Incomplete Disjunction
Fallacy of More Than Three Terms
Undistributed Middle
Illicit Process of the Minor or Major Term
Fallacies of the Dilemma
Non-Sequitur

RESULTS OF THINKING

Understanding and Explanation
Science
Philosophy
Prediction
Intelligent Living

PART I
KNOWLEDGE

CHAPTER I

INTRODUCTION

OUR civilization seems to have committed itself to the dogma of "Salvation by Education." As the Middle Ages trusted the church, our own time is trusting the school. Whatever the ill or danger, the school is expected to protect us from it. And as our difficulties increase, schools are being provided to prepare us to meet them. The cry is for schools, more schools, and better schools.

The school, of course, is not the only institution that serves the end of education. The press is, in a large sense, devoted to that purpose, as is the church; and there are yet other agencies.

With all the enormous expansion of the school as a means of education there is, unfortunately, a confused idea of just what education is, what it is expected to do, and how it is expected to do it.

The ages have said that "wisdom is the principal thing; therefore get wisdom." So the school, in its ranges from kindergarten to university, has been built to enable the people to "get wisdom." But what is wisdom? Clearly, something that will save us from disaster and enable us to get on in the world. The answer of everyone to this question as to the best

of all good things—wisdom—depends upon his own pressing needs at the moment. If he is suffering from ill health, wisdom is knowledge of medical science. If financial difficulties disturb him, it is knowledge of economic laws and business methods. If he is anxious about the fate of his country, he would have the next generation trained in the principles of good government and of democratic institutions. If he becomes concerned for the salvation of his soul, then it is that he believes that “the fear of the Lord is the beginning of wisdom.”

Thus it would appear that *knowledge* is an aim of education—knowledge of the actual facts which constitute the conditions of existence. This is believed by many to be the most needful of all things that can be attained by education.

Then there are those—and they are worthy of high consideration—who tell us that the supreme purpose of educational endeavor is *character*. The acquisition of those traits which are ideally approved and which, combined in the formation of a personality, win the sanction of society in general—this is regarded by many as the true aim of education.

There is yet another conception of the proper goal of education, namely, the power of personal adjustment to the world—*Adaptation*. Biological science reveals the continual dependence of the individual, and therefore the human race, upon the conditions constituting their environment. The individual is engaged in an incessant effort to employ those things about him which he finds favorable, and to avoid the influence of those he finds unfavorable, to his welfare.

Adaptation, biologists tell us, is the chief business of life for living things.

The acquisition of knowledge, the improvement of character, the increased adaptation to environment—these are ends which may well be the deliberate aim of education. How may they be attained?

Whatever other means may be proposed, no one can doubt that intelligence is the chief means for attaining them. If that be true, then education must concern itself with the attempt to improve the intelligence of its protégés.

To those who think of the future of the race as well as of themselves, the improvement of intelligence appears to be the supreme problem of education. For such, education means, first of all, training which results in broader, deeper, keener intelligence—one that will guide more certainly to a higher standard of human existence. Such intelligence must be quicker and more accurate in its efforts to apprehend the truth, more comprehensive in its range, more faithful in its retention of the truth it has apprehended, and more sanely practical in the use of its store of truth and in its guidance of our wills in their struggle after better living.

Those mental processes which reveal the intelligence in action are conveniently designated by the good old Anglo-Saxon word, *thinking*. It is about our thinking that we may well be chiefly concerned. Of course, there must be physical strength; there must be tenacity of purpose; there must be observance of moral principles; but unless there be clear thinking, these other qualities lose much, if not all, of their value.

Better thinking is the most hopeful means of attaining the highest aims of education, nobler character, profounder wisdom, and more practical adaptation to the world in which life must be lived.

The study of Logic deals with the technique of this mental process known as thinking. It is based upon long-continued observation of the thinking habits of the human race. It is a careful analysis of these habits for their possibilities and their shortcomings in the acquisition and utilization of knowledge.

CHAPTER II

KNOWLEDGE

The Nature of Knowledge.—It has been said that “a little learning is a dangerous thing.” Like most proverbs, this is not altogether true. Some knowledge may be dangerous, possibly, as some is worthless and as some is valuable—in fact, invaluable. But whether knowledge is valuable or not, dangerous or not, depends upon what it is, what it is about, and what is done with it, not merely upon the quantity of it.

By *knowledge* we mean a mental state which actually corresponds to objective reality. As a lake may have mirrored in it the outline of a mountain, so the mind may have reflected in it some of the nature of objective reality. Many mental states seem to have this peculiar capacity for truthfully revealing the world. This is such a commonplace truth that it is difficult to explain. To say that such mental states are “cognitive” does not help much. For a state of mind to be cognitive, or to have the characteristic of “cognition,” it must have this capacity for truthfully reflecting reality. This is an abstruse subject, not to be cleared up by the use of many words, even when they are long ones. Perhaps it is best to begin with the frank admission that we are

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going to use the word "knowledge" in the ordinary, everyday sense, as it is used by the "man on the street." We may say, for instance, and properly, that it is "common knowledge" that January is colder than June; that milk is food for mammals; that money serves as a medium for the exchange of property. We may be mistaken when we say we know a certain thing; but we know what we mean when we say it.

Strictly speaking, then, knowledge is to be regarded as a present state of consciousness which faithfully corresponds to existent reality, i. e., a reality other than the knowing state of consciousness itself. So conceived, we must admit we can have very little knowledge; for strictly speaking, knowledge would by this view be limited to but one thing at a time. But we cannot here use the term in such a restricted sense. We conceive our minds as being agencies capable of having such cognitive experiences and also as capable of retaining and possessing them after they have passed out of consciousness. So we may say we know all those things which we have known in the past and which are potentially recoverable to our consciousness by recollection. Thus, we know the multiplication table even while we may be thinking about the weather. We know many thousands of words and their meanings although for the moment our consciousness may be engrossed in the reading of logic. So we will consider here as our knowledge all that enormous accumulation of past experience which is actually available to us without having again to go through the original process of acquiring it.

Each person has what might be spoken of as a "store" of knowledge, of many kinds, obtained from many sources. Similarly, we think of society having a much larger store of knowledge which is the sum of what is known by the individuals constituting society, and which is transmissible from one individual to another.

In the early days of the race all knowledge was preserved in the minds of the people. Later, written language was invented as a means of preserving knowledge—although that knowledge may have disappeared completely from all the minds in existence. Libraries were made of these records of knowledge. Often these records were lost, to be in some cases resurrected to make their contribution to the current knowledge of the race from the lost knowledge of earlier times. Archeology is continually rescuing from the débris of former civilizations the knowledge then accumulated but which later was lost.

Knowledge Concerned with Facts and Principles.

—As stated above, knowledge is concerned with something—something other than itself. I say I know something, I have knowledge of something. It is nonsense to speak of knowing, unless there be mention of that which is known. The object of the knowing process is either a *fact* or a *principle*.

Facts.—A fact is an actual, existing phenomenon—a thing or an event. "The sun shines." "I am hungry." "Tonight will follow today." "Cæsar is dead." These are examples of facts. Presumably and actually, facts are infinite in number, most of

them, as yet, unknown, but any of them may be the object of knowledge.

Principles.—A principle is a general formula embracing many facts of similar nature. “The diameter and circumference of every circle are incommensurable.” “Bodies attract each other.” “Horses are herbivorous.” “Triangles with two equal angles are isosceles triangles.” “All men are mortal.” “Trees shed their leaves annually.” These are principles; that is, they are general formulas, each of which embraces many facts. And such principles, as well as individual facts, can be known. To know a principle is to know, potentially at least, many facts—as many as are embraced under it.

EXERCISE 1

Which of the following are facts and which are principles?

1. Water freezes at 32 degrees F.
2. Washington was the first president.
3. Oranges are a citrus fruit.
4. The orange I ate for breakfast was a citrus fruit.
5. Yale University is located at New Haven.
6. Planets revolve about the sun.
7. Molecules consist of atoms.
8. The square on the hypotenuse of any right triangle is equal to the sum of the squares on the two sides.
9. “The just shall live by faith alone.”
10. New Orleans is the greatest cotton market.
11. Transportation by inland water ways is increasing.
12. “Our little systems have their day;
They have their day and cease to be—.”

Use and Need of Knowledge.—Living things are able to continue to live because of certain characteristics or powers they possess and by means of which they are adjusted to the labyrinth of facts and forces which make up their environment. Very simple organisms have very simple relations with but a small number of these facts. Highly organized beings have many and exceedingly complicated relations with large numbers of facts of their environment. Each type of being is endowed with the powers necessary to keep up its system of adjustments to its environment of facts. Whenever an organism ceases to possess any of these essential powers, its adjustment breaks down and death may ensue. Death is always the result of some such loss of power.

In the simpler organisms, plants and the lower animals, the necessary adjustments seem to have required only physical characteristics, calling for physical organs. Higher up in the scale, consciousness appeared and played a large rôle in this adaptation of the organism.

Sensation has made possible vast ranges of adjustments not possessed by organisms which never had it. With the capacity for sensation, therefore, came opportunity for great development of living things. Perception brought another opportunity for many adjustments impossible without it. So when living things acquired even rudimentary powers for recognizing facts, they were able to develop in many directions not previously possible, and they maintained themselves against unfavorable conditions

as never before. Then came intelligence, which gave great momentum to the individual in his struggle for existence by adding to its power to make new adjustments. When this power of retaining past experiences came, accompanied by the power to rearrange, correlate, and apply such past experiences to novel conditions, it brought an enlarged capacity for making use of many facts which had previously been either indifferent or inimical.

So knowledge came into the world and is the foundation of the existence of the higher orders of living things, certainly of man.

The human species has won its exalted position by means of its superior intelligence, its superior ability to acquire knowledge. It has discovered facts and principles far beyond the ability of other animals to comprehend. By knowing these facts and principles, man has acquired his peculiar "dominion" over the world. It is estimated that within the last hundred years man has learned more about the universe than he had learned during all the previous ages of his existence. And all this increase of knowledge is, in a general way, useful to him. It increases his adaptation to the world. It is prolonging his life and enlarging his authority over his environment.

In this matter of possession and utilization of knowledge, the race is largely communistic. The benefits of the knowledge of a fact, if not that knowledge itself, usually come to all after its discovery has been made by one. Each of us is forever participating in the practical advantages of the knowl-

edge of others. The knowledge of the farmer regarding the growing of crops, the raising of live stock, and the management of his affairs, makes possible a supply of food for the millions who are wholly ignorant of all these matters. The manufacturer and the business man in turn bring to the farmer the innumerable articles on which his life depends. And so on through all phases of civilized society. Even the professional scientist, rare and secluded from the throngs of his fellow beings, knowing little and caring little, it may be, about the practical affairs that most concern the rest of us, is laying the foundation for civilization which is being continually renewed and reconstructed.

The knowledge actually possessed by any one person is only an infinitesimal part of that incalculable mass of knowledge possessed by the race as a whole, and of which he is a continual beneficiary. If this were not so, then there would be no civilization; indeed, in a peculiar sense, this *is* civilization.

Types of Knowledge.—The vast throng of judgments that appear in our consciousness appealing for our acceptance as grounds for living, arouse in us diverse degrees of confidence. Strictly speaking, it must be admitted that many of these ideas and judgments do not embody knowledge. They do not truthfully reflect reality. Clear thinking demands that we distinguish between the various grades of these judgments. Unhappily, we have no general term to substitute for that of knowledge, so we must be forewarned against the errors that may come from the ambiguity of that term as thus employed.

Among the various grades of knowledge, using this term in its broadest sense, may be distinguished the following:

Suggestion.—Any two ideas may be brought together in the form of a judgment. “The trees clap their hands.” “The stars are sweet.” Such juxtapositions of ideas are, of course, absurd, because they are completely out of harmony with our system of known facts. If there is no such conflict, a suggestion tends to be accepted, that is, it tends to pass over into some other type of knowledge. Only in a liberal use of the term can suggestion be said to be knowledge at all. In such statements as “The building is twelve stories high,” or “That oak has stood for fifty years,” there is no conflict. These fall into our accepted system of beliefs and can immediately be classified as a type of knowledge more definite than suggestion. But it is possible for suggestion to hang in suspense for an indefinite period. The molecular theory of matter is an example of a suggestion hanging thus in suspense. For centuries it was held as a mere suggestion while not regarded seriously by anyone. Then it was revived and accepted because new facts added to its probability if not to its certainty. The transmutability of the so-called physical elements, long regarded as an absurdity, may yet be an accredited theory. Instances of suspended judgment are often knowledge of this type called suggestion.

Opinion.—When a statement of a relation between two or more ideas falls into line with some experience we have had, with our habits of thinking, or perhaps

with our interests, we begin to give it credence. We say that it may be true, or that it probably is true, or that we believe it to be true. Here we are in the zone of opinion with its varying degrees of confidence. Opinions constitute a large portion of the material which passes through our minds. We are picking them up wherever we go. We rely upon them largely to lead us into practical action and, fortunately, we get on fairly well by means of them. We select our friends, choose our food, make our investments, and cast our votes, largely upon our opinions, rather than upon definite knowledge.

Conviction.—At an uncertain point opinion passes into conviction. Then it is we feel a decided additional pressure of confidence. Then we say “We know”; but we are exaggerating; we really do not know. We only feel very sure. We are willing to assume serious risks upon a test of the statement. When an opinion passes in our minds into a conviction, it means merely that we accept it as having a higher degree of probability—just how much higher cannot be determined.

This larger confidence may come from past experience. The sailor becomes “weather wise” so that he can forecast in confidence certain weather changes. The professional meteorologist has a much solider foundation for his decisions, although they may be the same as those of the sailor.

Proved Knowledge.—Fortunately, we are not left to be dependent merely upon our feeling of conviction. It is possible for us to test our judgments—some of them, not all. We cannot obey the scriptural

injunction to "prove all things," but we can prove many of them. And when we can, we ought to do so. Knowledge is said to be proved when such a demonstration of its proof is given as to preclude all doubt of its truthfulness. This demonstration is identification of a given judgment with a second which has been established as true; or if the first is not identified with the second, it is shown to be an inevitable resultant of it. That the square on the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides; that air contains nitrogen and oxygen; that petroleum deposits are found under the surface of the earth, are examples of proved knowledge. The history of thought is replete with examples of the final demonstration of judgments which had previously been held merely as convictions. There have been many cases, too, of the demonstration of the falsity of cherished beliefs. Progress in the use of this method of demonstration, through testing beliefs and convictions, has made greatly for the safety and welfare of humanity.

Axiomatic Knowledge.—Axioms are judgments which seem to be necessarily true without any demonstration; axioms are said to be "self evident." They are regarded as knowledge which is not dependent upon previous experience. "A part of a part is a part of the whole." "A thing cannot both be and not be," are examples of axioms. We should be careful not to take this doctrine of the axiom too seriously. Possibly there really are axioms, but judgments are often regarded as axiomatic when

they are held only as deep convictions. Many an announcement is made as being axiomatic when it is only a conviction held by a person unwilling to inquire into its grounds.

In logic there are four fundamental assumptions which are generally regarded as axioms. They are called The Postulates of Knowledge, or The Laws of Thought, and are:

1. The Principle of Identity:—"Everything is what it is."

2. The Principle of Contradiction:—"Contradictory judgments cannot both be true."

3. The Principle of Excluded Middle:—"Of two contradictory judgments, one must be true and the other false."

4. The Principle of Sufficient Reason:—"There is a sufficient reason for everything."

EXERCISE 2

I. Classify the following as to type of knowledge:

1. One-half of ten is five.
2. A communistic form of government may be successful.
3. Columbus landed on San Salvador in 1492.
4. Our educational system needs modification.
5. "The progress of civilization depends upon the discovering of the finest minds and training them to the limit of their capacity."
6. Applied science is no less important than pure science.
7. Fire burns.

8. The human species was evolved from some older species.
9. Men are more intelligent but less benevolent than women.
10. The yellow peoples are inferior to the white.
11. The meek shall inherit the earth.
12. The law of supply and demand cannot be avoided.

II. If you disbelieve any of the above statements, into what type do you classify its opposite statement?

Preference and Prejudice.—It is often exceedingly difficult to discover the ground of confidence we have in the truthfulness of our judgments. Habit is a powerful factor. The fact that we have already entertained a judgment makes it more welcome and more readily credited. This might be called the principle of “intellectual intimacy.” And if the judgment is a friend of long standing and has been entertained frequently, we are all but incapable of doubting it. We are “prejudiced” in its favor.

If the new judgment comes to us well recommended, that is, if it seems to be a member of a set or system of credited judgments, and hence comes with their recommendation and support, we admit it to our intellectual circle with little hesitancy because of its certified “respectability.” It may happen that the new friend comes to be preferred to the old.

A wholly novel suggestion with no support receives scant courtesy from most of us and may even be an outcast. It is condemned as outlandish. Great and true principles have thus “stood at the door and

knocked," age after age, before they won admission to the accepted body of belief of even the most intelligent section of the race. Some are still knocking, and must continue to do so.

Contradicting this natural aversion for new ideas is an almost immodest hospitality shown by some minds in their inclination to welcome any suggestion the first time it is offered. An historical writer in the New Testament condemned this as a peculiarly Greek trait of character.

The age of a person seems to be a factor in his disposition to accept novel proposals. Children are notably credulous, but with increasing age comes a disposition to "take it with a grain of salt." Later this ability to accept the new tends to grow less and less until it may seem to disappear altogether. It is said that the theory of the circulation of the blood, as announced in 1616 by the English physician, Harvey, was not accepted by any man more than forty years of age.

Whether age is or is not such a factor, certainly temperament is. Some persons seem to be predisposed to "believe all things." And they have their opposites. There are native-born "trusting Marys" as there are native-born "doubting Thomases."

There are many other factors that enter into our intellectual dispositions and determine our customary attitude toward judgments offered for our consideration. And they constitute grounds for what is properly designated as *prejudice*.

William James has written wisely and interestingly in proof of his view that the will is the foundation of

belief. This thought is embodied in the ancient proverb, "A man convinced against his will is of the same opinion still." Stubborn retention or rejection of a judgment, although it contradicts another for which sufficient reasons are available, is prejudice. All men are the victims of prejudices; it is too much to expect of human nature that it be altogether free from this weakness; but it is well to be forewarned against it that its baneful influence may be avoided as much as possible. Our only relief from this misfortune comes from wider knowledge and more accurate thinking.

Sources of Knowledge.—The knowledge that each of us possesses, or that system of judgments which we regard as knowledge, has come from various sources. The most important of these sources are discussed in the following paragraphs; but it is not claimed that this list of sources is exhaustive.

Tradition.—There is a great body of knowledge which descends imperceptibly from father to son, from one generation to another. This is called tradition. From this source come history, folk-lore, long-standing superstitions, and the like. Much traditional teaching, it must be admitted, is false, but much of it, fortunately, is true. The judgments comprising traditional knowledge are handed down through successive generations, often accompanied by little or no attempt at demonstration. They acquire a kind of authority from the simple fact of their repeated previous acceptance. This authority, after sufficient time, is venerated and may receive what resembles religious sanction. That means that

to question the validity of such traditions may be counted an act of impiety.

Traditions often stand cruelly in the way of the attainment of truth and may result in widespread suffering. Only gradually is the mass of race opinion based on false tradition worn away by the thinking and criticism of the more courageous members of society.

Current Report.—Similar to tradition is current report. Beliefs pass freely from mouth to ear, or from pen to eye, and are accepted because they are useful or entertaining and are not denied. Beneath the free circulation of current report is personal interest. This may come from personal profit, but not necessarily so. It may be an appeal to emotional excitement. The modern journalist is continually talking about the "human interest" of his stories. But such human interest is the matrix into which vast quantities of falsehood are poured and congealed into enduring form. Carlyle's denunciation of pre-revolutionary France as a world of lies would be applicable, in the opinion of pessimistically minded persons, to any other time and people. It must be granted that there is much falsehood in circulation and that it is the occasion of a great deal of mischief. But it should also be granted that there is much truth in circulation even though some of it may be greatly exaggerated and distorted.

Testimony of Others.—The positive assertion of a known person is the source of many of our judgments. It is, on the whole, more trustworthy than common report. We can, at least, locate the responsibility

for an opinion which we hold because someone we know told it to us, as we cannot when we have it because "they say."

In many ways we are totally dependent upon the direct testimony of other persons. They have had experiences yielding them knowledge which we need to use, and the only way we can do so is to take as true what they tell us. But such testimony is notoriously fallacious. It is subject to corruption due to the ambiguity of words and phrases, the uncertainty of memory, the inaccuracies of observation, the distortions of imagination, and intentional mendacity. When such testimony must be carefully weighed, as in courts of law, it is customary to require the supporting testimony of independent witnesses. This custom is reinforced by that of the administration of an oath. Because of the presumptive solemnity of this ceremony it was supposed that sworn witnesses would be more unwilling to make false statements. This quasi-religious sanction has doubtless lost much of its original value, but the criminal penalties attached to it have some deterring influence upon the witness who is tempted to deviate from the truth.

Much of the most valuable knowledge is in the possession of persons who have had peculiar opportunities for acquiring it and whose profession it is to make it available for their fellow mortals. Professional knowledge, covering in a technical way some field of human interest, is to be counted here. The mass of facts known by the lawyer, the physician, the electrician are examples of this kind of knowledge

which the layman has no expectation of acquiring himself, but which he expects to be at his command when needed.

The so-called "specialist" in any line is one who presumably has useful knowledge available for others on certain conditions but which they cannot hope personally to possess on account of the difficulty of acquiring it.

Telepathy, Intuition, Inspiration, Hunch.—Some of our judgments come to us from mysterious sources. We may not be aware of the presence of conditions which ordinarily attend the acquisition of judgments. Then when we attempt to account for them, we imagine that some supernormal forces or agencies have contributed them to us. The human heart loves mystery and the human imagination revels in the opportunity mystery affords. All this in a large measure explains the belief in *telepathy*, the transfer of judgments from one mind to another without the ordinary physical means; *intuition*, the direct knowledge of external reality without the usual perceptive processes; *inspiration*, the communication of truth to a mind by a personality not related to any perceived body; and *hunch*, the judgment which is dependent upon sheer feeling.

These are uncertain sources of true judgments, to say the least. No reliance can be placed upon a judgment derived from any of them except after the application of the ordinary reliable tests of validity.

Individual Perception.—It would seem that no one can have the same degree of confidence in a judgment, whatever its source, as one can have when it is a

product of one's own personal experience. We rely upon our own sense organs just because they are ours—because they are a part of us. We may be forced by some theoretical argument to desert, for the moment, our confidence in them, but in any practical test we come back to our confidence in our own personal experience, our individual perception. Actual contradictions between percepts occur, however, and they are quite embarrassing. "Do my eyes deceive me?" we exclaim on certain occasions. The leaning stick thrust part way into the water, straight to the touch, but bent to vision, caused ages of contention and speculation. The echo presented a decidedly practical problem, even to our animal predecessors.

Thinking.—In the most rudimentary stages of the acquisition of knowledge it is possible to become aware of a fact without any effort whatever. The mind may be quite passive, merely allowing external phenomena to impress themselves upon it in the form of sensations. But such a strictly passive method of acquiring knowledge is a rather unnatural experience. Ordinarily, the mind reacts upon such sensations, transmuting them into percepts; these are then worked up into concepts by merging those of like character into a whole. These simple acts of the mind are the rudiments of thinking.

Thinking begins very early in life, in babyhood no doubt, and it goes on more or less continuously as long as life lasts. As it goes on the thinker may be aware of it as such, but usually he is only slightly so. A person, when thinking, is much more concerned

with the facts, the things, the ideas, with which his thinking deals and the conclusions which he reaches, than he is with the thought process itself. But thinking, as reason in action, or *reasoning*, goes further. Thinking enables us to test, to build upon, and to expand our knowledge obtained from other sources. By thinking, we rearrange, readjust, and re-relate known facts in such a way that new facts are derived. By the combination of several facts of like nature, thinking derives a general principle, an *empirical law*. By the combination of a known empirical law with a certain individual fact, it derives another fact or empirical law. Thinking thus contributes greatly to our practical knowledge.

The power, the capacity, the so-called "faculty of thinking" is traditionally known as *reason*. Over all our experiences which seem to bring us knowledge, reason acts as judge. It decided that the stick was straight, not crooked, when thrust into the water; it decided that the minute points of light called stars were in fact colossal suns placed at inconceivable distances from us; it decided that the qualities of familiar objects are illusive, that the objects themselves are illusive, that what really exists is infinitely complicated groupings of inconceivably small and intricate entities called molecules, atoms, ions, etc. Reason has thus built up a theoretical world, totally different from the world of facts as we personally perceive it, and then it insists upon our accepting this new world as a substitute for our own perceived world. And reason has succeeded. Intelligent people have completely submitted to its decisions.

The study of how reason has done this, in other words the study of the processes of thought, is called *Logic*.

EXERCISE 3

I. Classify the following as to source of the knowledge expressed, (a) for you personally, and (b) for the race.

1. Nutmeg hung about the neck cures rheumatism.
2. Property rights should be protected by government.
3. Fruit is healthful food.
4. The sinking of the *Titanic* was caused by a collision with an iceberg.
5. The multiplication tables.
6. Water consists of hydrogen and oxygen.
7. Kings exercise their authority because of divine right.
8. The earth is flattened at the poles.
9. Quinine cures malaria.
10. Tuberculosis is caused by a specific bacillus.
11. Martin Luther was responsible for the protestant revolution.
12. You, personally, deserve more than is accorded you.
13. The Pilgrims came to America on the *Mayflower*.
14. Shakespere was the greatest English dramatist.

II. If you disbelieve any of the above, what is the source of your doubts?

III. Classify the above as to type of knowledge.

IV. Compare the various sources of knowledge as to reliability.

PART II
MATERIALS OF THINKING

CHAPTER III

IDEAS AND TERMS

The mental process which makes up the conscious experience designated as *thinking* is exceedingly intricate. By analysis, however, it will be found to consist of simple states of consciousness, called *ideas*, and their recognized relations to one another. These known relations are woven into as extensive and complicated patterns as we may wish. When two ideas are associated in a known relationship, they form a *judgment*. When judgments are combined into an intelligible system, they constitute what is called a *train of thought*. These ideas and their known combinations into systems, simple, as in the judgment, or complex, as in a train of thought, constitute the *materials of thinking*.

Ideas.—Ideas come primarily from simple awarenesses in consciousness. From these awarenesses what are known as *percepts* arise, and *concepts* are built up. These percepts and concepts are the ideas with which we think. Locke explains an idea as being “whatever it is which the mind can be employed about in thinking.”

Terms.—Terms are the symbols for these ideas. A term represents the idea it symbolizes. My mental image of my home is an idea. The phrase “my home,”

used to express that image, is a term. My conception of honesty is an idea. The word "honesty" names that idea and is a term. Ideas are the purely subjective material of our thought processes, while terms are the objective evidences of these ideas.

Anything whatever which can serve as the symbol of an idea, and so can represent or stand for it, may be a term. Usually terms are words or groups of words, as "museum," "the winding river," "memorial for the soldiers of the World War," "the aqueduct under the Hudson in New York," "the reasonableness of human nature,"—each of these represents an idea that was in the mind of the writer and conveys an idea to the reader.

Words were made for the purpose of representing ideas. By representing an idea known to two persons, a term becomes the means of conversation between them. It is said to "convey" an idea from one to the other.

Anything else which is accepted as symbolic of a given idea,—a sign, a picture, a gesture,—may serve as a term as well as a word. The visible figure of a cross whenever used as a symbol is a term as certainly as is the word "cross." The outline of a crescent conveys an idea rich in emotional associations to millions of Mohammedan people. Whether we use a word or some other representation of our idea depends upon circumstances; but words, spoken or written, are the terms we most frequently use just because they are so convenient.

Ambiguity of Terms.—Language embodies an enormous number of terms designed to give expres-

sion to our subjective experiences. Language is an inadequate device for that purpose, but it is the best we have. Because it is so imperfect, it is being changed continually. Such changes may be made purposely, but usually they come about by natural growth. The many obsolete meanings for terms found in dictionaries constitute a veritable graveyard of terms. They give evidence of this tendency to change in meaning, as do also the several meanings given for a single term. Terms, then, are fluctuating things. This instability of meaning of terms gives rise to what is called *ambiguity*. The frequency of such "multiple meanings" of terms, even those in common use, is surprising. This becomes apparent to one who recalls the numerous meanings for such simple words as "case," "time," "date," "course," and "school."

Much confusion of thought results from this ambiguity of terms. Only by exact definition of a term can it be used without misunderstanding resulting. And then extreme care must be taken to use the term only with just the meaning ascribed to it by the accepted definition.

So in expressing our ideas, we encounter, first, the difficulty of finding terms that symbolize these ideas adequately, even to ourselves; and secondly, the probability that these terms may not arouse in the minds of others just the ideas we have in our minds. Since the experiences of any two persons differ, the terms that symbolize certain ideas for one might symbolize quite different ideas for the other. In fact, it would be impossible for a term to convey

precisely the same idea to more than one person, since ideas must reflect their personal experiences, and experiences differ. These discrepancies in the significance of terms, due to our different individual experiences, are sometimes called *individual differences*. They must be taken into account in using terms as means for conveyance of thought.

Abstract and Concrete Terms.—There is an important division of terms as regards the nature of the subjects they designate. One set of terms represents ideas of things, the other represents ideas of qualities. The first are concrete; the latter are abstract. “Sky,” “gas,” “railroad,” “state,” “a just man,” “a high tower,” “a wide river,” are concrete terms. “Brightness,” “expansibility,” “durability,” “efficiency,” “justness,” “height,” “width,” are abstract terms. The former, we shall learn later, refer to denotation, the latter to connotation.

EXERCISE 4

Show the ambiguity of each of the following terms:

- | | | |
|----------|--------------|------------|
| 1. Star | 6. Pole | 11. Chair |
| 2. File | 7. Magnetism | 12. Dog |
| 3. Rent | 8. Post | 13. Foot |
| 4. Light | 9. Ball | 14. House |
| 5. Page | 10. Justice | 15. Church |
-

Denotation and Connotation.—Every term has two characteristics which give to it its significance

and value. Rob a term of either of these and it would be as meaningless as childish scrawls made before one learns to write. To understand these two characteristics, and to be able to distinguish clearly between them, are essential to the effective use of a term, whether its task be to convey an idea from you to another or to you from someone else. These characteristics are given the names of *denotation* and *connotation*.

Denotation.—The term “man” may be applied to each and every being having the qualities which make it a man. The term designates or denotes each and every being to which the term “man” may be applied. All such beings as Adam, Moses, Socrates, Cæsar, Newton, and all others so designated, taken together, make up the denotation of the term “man.” By the denotation of a term, then, is meant all the things that may be designated by that term.

Consider comparatively the following terms for their denotation and note how denotation is effected by a change in the terms:

Rivers.

The rivers of North America.

The Hudson River.

The first term, “rivers,” includes, of course, all bodies of water to which that name may be applied, regardless of location or size: the Euphrates, Nile, Thames, Amazon, Jordan, and all others, a complete list of which would itself fill a small book. The second term, “rivers of North America,” denotes all those bodies of water that may be designated as rivers

which are found in North America, including the Yukon, the St. Lawrence, the Columbia. Here also a list of the entire denotation would be a long one, but much shorter than the denotation of the term "river," since only those rivers are included or denoted which are in North America. To give the Nile or the Amazon as part of the denotation of "rivers of North America" would be obviously incorrect. The term "Hudson River" denotes but one thing—a river in the northeastern part of the United States known as the Hudson.

EXERCISE 5

From the list below select those terms which are part of the denotation of: (a) flower; (b) grain; (c) crime; (d) honesty; (e) clock.

Selling alcoholic liquor

Theft

Reporting the finding of a five-dollar bill

Corn

Hall-clock

Alarm clock

Wheat

Perjury

Easter lily

Refusing to tamper with records for submission to bank
examiners

Millet

Time-piece on the county court-house

Paying a living wage to employees

Refusing to pay a living wage to employees

Flour
Murder
Tulip
Springs
Rye
Wheels
Blossom
Pansy
Petals
Circulating libelous reports
Retracting a statement found to be erroneous

Connotation.—Every term that we use denotes, as explained above, one thing or more than one. If we would use a term rightly, it is essential to know whether or not a given thing is a part of its denotation. How are we to know this? How shall we know, for instance, whether or not X is included in the denotation of the term Y; whether or not sunflowers are denoted by the term *compositae*? This determination of the denotation of a term is the function of connotation.

The connotation of a term is all the essential characteristics or qualities of that term. All those characteristics or qualities which a thing must have in order that it may be designated by that term and without which it would be excluded from that designation, constitute the connotation of the term.

The connotation of the term “man” is the total of all those necessary attributes which a man possesses, by virtue of which he is a man, and without any of which he would not be a man. These include, for

instance, possession of a physical body having certain form, function and consciousness, embracing sensation, perception, intelligence, emotion, etc.

In contrast with the above list of characteristics are such possible characteristics as possession of red hair; being six feet tall, being a member of the Caucasian race; having a university degree. These characteristics, being possessed by some men only, are clearly not essential to the denotation of the term "man," consequently they are excluded from its connotation. They are called accidental characteristics in contrast with the essential ones which constitute the connotation of the term.

Sometimes the term "connotation" is used with a personal, individual interpretation. It then means *my* connotation. My connotation of any term depends upon my own experiences and must differ somewhat from the connotation of anyone else, since his connotation must likewise result from his experiences. However, our individual connotations for terms must have elements in common if they are to be used in conversation. Otherwise attempts at communication would be as futile as those at the tower² of Babel. It is with the common element of these individual connotations that connotation as used in logic is primarily concerned.

EXERCISE 6

I. From the list that follows select those terms which are part of the connotation of: (a) city; (b) government; (c) flower; (d) planet.

Power to control people
 Mobility
 Location
 Possession of plant reproductive organs
 Luminosity
 Having population
 Power to decide controversies
 Having a mayor
 Mars
 Emitting a pleasant odor
 Commercial value
 Having a president as executive
 Morality
 Color
 Origin
 Visibility
 History
 Power to make rules of conduct
 Possession of buildings
 Revolution on axis
 Destructibility
 Possession of petals
 Authority
 Beauty
 Organization
 Form

II. Select from the following list those terms which are a part of the connotation of "buildings":

Four-storied
 Made of brick
 Height
 Large
 Small

Having a foundation
 Location
 Having windows
 Having electric lights
 Walls
 The Woolworth Building in New York
 Tallest building in the United States
 Used as an office building
 Size
 Made of material
 Owned by the Woolworth Co.

III. Give some of the denotation and some of the connotation for each of the following:

Science	Clergyman
History	Oratorio
Language	Political party
Automobile	Beauty
Dictionary	Honesty
Hereford cattle	Electricity

Relation between Connotation and Denotation.—

For an illustration, let us consider the relation between the connotation and denotation of the list of terms used in the discussion of denotation: "rivers," "rivers of North America," and "the Hudson River."

The connotation of "rivers" would be the possession of width, depth, length, source, mouth, river bed, margin, water, etc., including all those characteristics which every river must have. The denotation, as explained, is all the rivers of the world, including the Euphrates, Nile, Amazon, etc.

Now consider the term "rivers of North America."

Is its connotation greater or less than that of the term "rivers"? Clearly it includes the entire connotation of the term "rivers" plus such characteristics as being located in North America, north of the equator, in the western hemisphere and others peculiar to all rivers in North America. The connotation then of the new term "rivers of North America" has been greatly increased over the connotation of the term "rivers." The denotation of "rivers of North America," as explained in a previous paragraph, is much less than the denotation of "rivers," which embraces all the rivers of the world, including those of North America.

The term "Hudson River" has a still larger connotation. Its connotation includes that of "rivers," since it is one of them; it includes the entire connotation of "rivers of North America," as it is one of them; and in addition, it includes all characteristics peculiar to itself, as location in northeastern United States, etc. Its denotation consists of but one thing.

In these three terms, "rivers," "rivers of North America," and "Hudson River," it may be noted that the denotation was decreased in going from one to the next following until it changed from all rivers to one river, while the connotation of these same terms was greatly increased—increased from the comparatively few characteristics possessed in common by all rivers to the many characteristics possessed by one particular river. So it is with terms generally; if by changing a term we increase connotation, we have by that change decreased denotation. Thus we get the rule: *Connotation and denotation vary inversely.*

EXERCISE 7

I. Arrange the terms in each of the following groups, in the order of the comparative extent of their denotation:

Navy beans

Dicotyledon

Plant

Bean

Bush bean

Citizens of Calcutta

Asiatics

People

Mammals

Calcutta police force

Calcutta police captain

Botany

Knowledge

Biology

Plant Histology

Science

Honest Acts

Payment of income taxes

Payment of debts

Moral conduct

Payment of taxes

II. Arrange the above terms in the order of the comparative amount of their connotation.

Division and Classification.—From the study of denotation of terms, we see that wide ranges of things are sometimes included under one term. To be dealt with conveniently, these things must be put into groups in some systematic manner, that is, they must be classified. A *classification* is a systematic arrangement of the denotation of a term. It is formed by a *division* of the denotation of that term into groups.

For example, the Federal Government has divided

its post offices into those of the first class, second class, third class, and fourth class. Every post office in the United States, according to the amount of its cash receipts, falls into one and only one of these four classes. The state in which it is located has no bearing upon its place in this classification, nor has the length of time it has been established, nor the political affiliations of its employees. We have then a classification of the post offices of the United States, divided upon the basis of the amount of their cash receipts.

The powers of government are: legislative, executive, and judicial. This is a classification of the powers of government, divided upon the basis of their function. Every power any government may possess is included in one of these three classes and in one only.

Special names have been assigned to terms when they are used in a classification. The term with the larger denotation, the one whose denotation is being divided into smaller groups, is called the *genus*. These smaller groups or subdivisions of a genus are called the *species*. In the first example of classification given above, the genus is "post offices of the United States." The species are "post offices of the first class," "post offices of the second class," "post offices of the third class," and "post offices of the fourth class." In the next example the genus is "powers of the government." The species are "legislative," "executive," and "judicial."

A classification of plane triangles divided on the basis of the relative length of sides would be:

Genus—Triangles.

Species—	{	Equilateral.
	{	Those with two sides only of equal length.
	{	Scalene.

No plane triangle can be drawn that does not fall into one of these species. Nor can any be drawn that could fall into more than one. The classification of triangles need not stop with this one division. It may be carried a step further by subdividing each of the species. Scalene triangles, for instance, may be divided into those possessing a right angle and those possessing no right angle. In that case scalene triangles becomes the genus for these two species. In any classification, then, a term is species with reference to the larger group above it, of which it is a subdivision; it is genus with reference to the smaller groups below it, which compose it. Thus the same term may become both a genus and a species.

In each classification given above a single basis of division was used in dividing the denotation of the genus into species. In the classification embracing "post offices of the United States," the basis of division used is *revenue*. In the classification of "powers of government," the basis of division used is *function*. In the classification of "triangles," the basis of division is *relative length of sides*. It is so with every classification; a single basis for the division of each genus must be selected and used throughout that division. The basis adopted depends upon the purpose of the classification. For

instance, in the classification of post offices, location might have been the basis of division that best suited the purpose. Then the species might be post offices in Maine, post offices in New Hampshire, post offices in Vermont, and so on until each of the forty-eight states had been named. But once selected, a basis must be adhered to throughout the division for which it was selected, else overlapping of species or the exclusion of part of the denotation to be classified will result.

Material for these bases of division is furnished by the characteristics of the things to be classified, and each species must possess a characteristic which is peculiar to it alone, not possessed by any other of the species that compose its genus. This exclusive characteristic is called its *differentia*. In the classification of triangles given above, the general characteristic chosen as the basis for division was "relative length of sides." The exclusive characteristic possessed by the species "equilateral" is "all sides of equal length." This is its *differentia*. The *differentia* of scalene triangles is "all sides of unequal length."

Thus it is seen that *division* is the process of separating the denotation of a genus into its species. A *classification* is the systematic arrangement of the denotation of a genus resulting from this process of division. To *classify* a thing is to assign it to its proper place in a classification.

Sometimes the one term "classification" has been used to cover all three of these concepts. The above terminology, however, is consistent with good usage, and adds clearness to this subject.

Rules of Division.—The observance of the following rules is necessary for the correct division of a genus into its species.

1. The division must be made on a single basis.
2. The entire denotation of the genus must be included in the species; that is, the sum of the species must equal the genus.
3. The species must be mutually exclusive, that is, with no overlapping.
4. Each step should be proximate to the one preceding it.

The organization of one's known facts into classifications, and the classifying of new facts into accepted classifications already made, constitute a large portion of one's mental activities. Very frequently for the individual, and in many instances for the race, knowledge is too incomplete to admit of exact classifications. Then recourse is had to what is known as "working classifications." Such working classifications are defective often in that they have no exact line of demarcation between the species, or the denotation of the genus may be incompletely known, so we cannot be sure that all of it is classified and no foreign material included. The library classification of books is an example of a working classification, since it contains much overlapping of species. It also demonstrates the practical value which a working classification may have.

While classification is a common and a necessary proceeding in everyday life, it is, if possible, even more important in some scientific transactions. In

some of the sciences the classification of the enormous array of things which are included in their specific domains becomes exceedingly complicated. A good example of such a science would be found in systematic botany, which undertakes to classify all plants. Plants differ so widely and in so many different ways that it is not surprising that many attempts have been made to classify them satisfactorily. Zoölogy, entomology, and geology are examples of sciences in which scientific classifications are highly necessary.

EXERCISE 8

I. Make a logical classification of each of the following:

- | | |
|------------------------|-----------------------------|
| 1. Geometrical figures | 6. Social organizations |
| 2. Heavenly bodies | 7. Newspapers |
| 3. Machines | 8. Birds |
| 4. Governments | 9. Educational institutions |
| 5. Foods | 10. Sciences |

II. What has been the basis of division in each case?

III. Make another classification of each, employing another basis of division.

IV. Criticize the following attempts at classification:

1. Matter.

 Animate

 Plants

 Dahlias

 Exogenous

MATERIALS OF THINKING

- Parasitic
- Animals
 - Vertebrate
 - Invertebrate
 - Insects
- Inanimate
 - Solids
 - Metals
 - Non-metals
 - Gases
 - Combustible
 - Non-combustible
 - Air
 - Oxygen
 - Hydrogen
 - Vapor of water
 - Helium

2. Animals

- Fur-bearing
 - Fox
 - Squirrel
 - Mink
 - Plantigrades
 - Mammals
- Feathered
 - Birds
 - Turkeys
 - Doves
 - Corvidae
 - Ducks
 - Sparrows

3. Cities

- Population of 25,000 and less
- Population of 25,000 to 100,000, inclusive

Population of 100,000 to 1,000,000, inclusive
Seaports
Political capitals

Definition of Terms.—When all the connotation and the denotation of a term are known, and also its place in the general classification of the things of the universe, we may truthfully say that we thoroughly know that term. In the practical use of terms in thinking or in conversation, however, some way of abbreviating this knowledge or of summarizing it is needed. The definition does this.

A definition is a statement placing exact limits upon the application of the term defined. It completely isolates the denotation of that term from all else in the universe.

A definition can take any of several forms, but the one generally agreed upon as most satisfactory is that which has long been termed the “logical definition.” This consists of two distinct parts. The first part is a statement locating the thing to be defined in the group which, if possible, is the nearest larger group or species; if the term is the name of a species, it must be located in its *proximate genus*. The second part is the mention of whatever sets it off certainly from all other members of the group, that is, its *differentia*. “A circle is a plane geometrical figure bounded by a line, every point of which is equidistant from a given point.” In this definition, the nearest larger group is “plane geometrical figures,” which includes innumerable figures as well as all circles.

The exclusive characteristic is the fact that the circle is "bounded by a line, every point of which is equidistant from a given point." It is an exclusive characteristic because every circle has it and no other plane figure has. Should any other geometrical figure acquire that characteristic it would thereby become a circle.

The following definitions exhibit the two essential parts of a logical definition:

"A circle (term to be defined) is a plain geometrical figure (proximate genus) bounded by a line every point in which is equally distant from a given point (differentia)."

"Geology (term to be defined) is that physical science (proximate species) which is concerned with the constitution and structure of the earth (differentia)."

"A term (term to be defined) is the symbol (proximate genus) of an idea (differentia)."

When we encounter a term whose meaning is unfamiliar to us, the suggestion of a familiar synonym for it may aid in understanding it; but a synonym for a term is not a definition, and it must not be allowed to take the place of one. It can set no exact limits upon the application of a term.

Closely akin to definition is DESCRIPTION. In fact, a description may constitute a definition, but it may also, and usually does, include other material than that needed for a logical definition, and it may omit some of the essentials of a good definition. Any characteristic of a thing, when stated, is to that extent its description, and a summary of all its characteristics would be a complete description of it.

In contrast, the logical definition gives only the *differentia*, the characteristic which is peculiar to the term being defined—this in addition to locating it in its group.

EXERCISE 9

I. Which of the following statements are complete definitions?

1. Geometry is the science of space relation.
2. Salt is the chemical union of sodium and chlorine.
3. A square is a figure having four equal sides.
4. A classification deals with the denotation of the term chosen for genus.
5. A term is a symbol for an idea.
6. Honesty is the best policy.
7. An ellipse is a flattened circle.
8. A drug store is a place where drugs are the chief article of commerce.
9. A thing of beauty is a joy forever.
10. A constitution of a state is the supreme law of that territory.
11. Mental phenomena are the subject matter of the science of psychology.
12. Religion is the belief in the existence of spiritual things.

II. Give logical definitions for:

- | | |
|-------------------|-------------------|
| 1. Genus | 5. Connotation |
| 2. Term | 6. Denotation |
| 3. Differentia | 7. Classification |
| 4. Ambiguous term | 8. Knowledge |

- | | |
|--------------|------------------|
| 9. Principle | 15. Event |
| 10. Algebra | 16. Faith |
| 11. Geology | 17. Mercy |
| 12. History | 18. Value |
| 13. School | 19. Tuberculosis |
| 14. Progress | 20. Comedy |

CHAPTER IV

JUDGMENTS AND PROPOSITIONS

The Nature of Judgments and Propositions.—Any intelligent being can entertain in consciousness two or more ideas and recognize relationships between them. This association in consciousness of two or more ideas and the recognition of a relation between them is called a *judgment*. When a judgment is expressed in language, it is called a *proposition*. Judgments, like ideas, are subjective. Together they constitute materials of thinking. Propositions, like terms, are objective. They serve as representations of these materials. The following are propositions, that is, expressed judgments. Each states a relationship between the underlined terms.

All A's are X's

A triangle is a three-sided figure.

The government of the United States is
a democratic form of government.

No man is perfect.

Some governments are not democratic govern-
ments.

Symbolic Aids.—Frequently certain advantages are to be gained by using in a proposition terms that

are more widely symbolic than word-terms. Here as in mathematics letters serve most conveniently. The first proposition above, "All A's are X's," taken literally, is nonsense. Taken symbolically, it offers a wide range of meaning. "A" is the symbol of any term whose denotation is entirely included within the denotation of some other term. "X" is the symbol of any term whose denotation includes within it at least all of the denotation of "A." "All A's are X's" symbolically represents all such propositions as:

All living things are mortal.
All material bodies have weight.

The use of such general symbols in Logic introduces a greater flexibility, comparable to that which algebra has as contrasted with arithmetic.

In a somewhat similar manner geometry may be an aid to logic. By employing the "Circles of Euler," the relation between the terms in any proposition can be graphically exhibited. This use of geometric figures can often make clear what mere words may have failed to do.

In the proposition, "All A's are X's," since the denotation of the predicate "X" must be greater than that of the subject "All A's", or at least not less, the relation of the two terms can be represented by two circles, one to represent each term with the subject circle drawn wholly within the predicate circle. (Fig. 1.)

All A's are X's

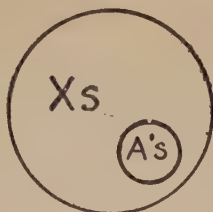


FIG. 1

When the subject term is not distributed, as in "Some A's are X's," its circle must lie at least partly within the predicate circle. Part of the subject circle may lie without the predicate circle, but it may lie wholly within it. The uncertainty of that portion of the subject circle not within the predicate circle is indicated by the broken line. (Fig. 2.)

Some A's are X's

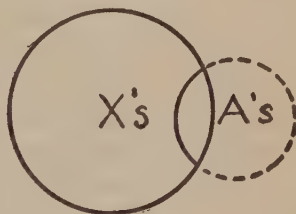


FIG. 2

Normal Form of Propositions.—The terms being associated in a proposition are called *subject* and *predicate*, as in the study of sentences in grammar. In the normal form of a proposition the subject is given first and the predicate last. They are connected by a *copula* which must contain the present tense of the verb "to be," that is, either "is" or "are." The normal order of the three parts of the proposition given above are here shown:

<i>Subject</i>	<i>Copula</i>	<i>Predicate</i>
All triangles	are	three-sided figures.
The U. S. govern- ment	} is	a representative form of government.
No man	is	(a) perfect (being).
Some books	are not	(books) worth reading.

Propositions are often stated in other than their normal form, and to make their meaning clear they must be reduced to normal form. A study of such reduction comes later.

Truthfulness of Judgments and Propositions.—It has been shown that any two ideas can be brought together into a judgment. "A is B," "The moon is green cheese," "Columbus discovered the Pacific," "Gold is worthless." All these judgments make a pretense of proclaiming the truth, but they do not do so. And this raises a most important question; namely, when is a judgment true and when is it false?

Anyone who could invent a mechanism or a method for accurately classifying judgments into true and false would be an unrivaled benefactor of the race. But a more fundamental question is: "What is meant by 'truthfulness'?" If we hope to answer this question, we must keep in mind some terms as previously defined. Reality is that which actually exists. A fact is an individual phase of reality. An idea is a state of mind presumably corresponding to objective reality. *Truthfulness*, then, might be considered as the characteristic that an idea or a judgment possesses when it does so correspond to reality; falseness, when it does not. This, in fact, is

what we mean when we speak of ideas and judgments as true or false.

Either or both of the ideas in a judgment may be true and the judgment false. Our idea of the moon may correspond to that body and therefore be true; likewise, our idea of unripe cheese; but our judgment identifying them is ridiculous. Contrariwise, it is conceivable that two false ideas might be united in a true judgment, as "Mermaids are beings, part fish and part human."

It was said above that ideas and judgments were presumably true. It is their very nature to make such pretensions, and when they fail to do so they lead us into error and misfortune. Children and credulous people do not challenge propositions. Thoughtful people criticize and test their ideas and judgments and find it necessary to discard many of them as misleading and dangerous. This is a good habit, but it may become excessive, resulting in an habitual state of skepticism equally misleading and dangerous. A school of philosophy, which has persisted through the ages, teaches that it is impossible to know whether any judgments or ideas are true; other philosophies have held that, in fact, they cannot possibly be true at all.

The common test of truthfulness is the principle of consistency. When a judgment is in complete harmony with our system of judgments, particularly with those that have been accepted and have long been held as true, then we accept it and add it to our stock of judgments which we believe and trust. This process of increasing our stock of true judgments

is called "learning." But when a new judgment does not harmonize with our system of accepted judgments, we condemn it as false and discard it, or we accept it as true and then we discard those which are in discord with it.

Field of Application of Judgments and Propositions.—When we think purposefully we usually do so to gain a fact we need to know or to increase our knowledge of facts in order to gain control over them. As has been stated, the judgments we employ in thinking are true or false according as they actually do or do not correspond to objective reality. The ideas we put together in each of these judgments are truthful or false as they correspond to objective facts.

It has been shown how the terms we use to express our ideas are often tainted with indefiniteness, that is, they are afflicted with ambiguity, and therefore may lead to error when used to convey truth. There is a similar uncertainty of meaning attached to the propositions we employ in expressing our judgments. It is unfortunate that the means we have to adopt in our search for truth are such that they may themselves lead us into error, but we cannot deny that this is the case. Indefiniteness in our concepts and vagueness in our language thus often play havoc with our conclusions and with our utterances.

Our troubles in thinking come largely from our failure to keep clearly in mind the actual limitations upon the scope of our ideas and judgments, and the range of their application as we use them at the moment. For example, the assertion of the Decla-

ration of Independence that "all men are created equal" has led to much disputation. Men have formed themselves into groups, not strikingly friendly to each other, according to the interpretation they have placed upon these words. Although "all men" is the subject, apparently meaning each and every human being, no advocate of the proposition can take that term as having such a wide denotation. "All men" may mean all human beings that are, ever were, and ever will be. Then it is conceived in its broadest field of application. It may mean only those now living. It may mean only masculine human beings. Or again, it may mean only those who have certain pronounced characteristics, such as physical powers, courage, or what not. Similarly with the predicate of the proposition. "Equal" has even greater uncertainty of signification. "Created" brings its peculiar doubtfulness of meaning, too. So if this or any other general proposition is to have any value, those who use it must state, or assume as having been stated, definite limitations to the application of the terms involved. Probably what was, and is, intended by the famous dictum is an expression of faith that in our time that form of social organization is superior in which the individuals constituting it are treated in the same manner by the laws; that is, that they should have similar political rights. Even this principle would be subject to conditions brought about by such emergencies as war.

The meaning of a proposition, then, and also its truth or falsity, depend upon its assumed range or *field of application*. A statement may be unmis-

takably true when it is understood that it applies in one way and false when it has a different application. The field of application must always be taken into consideration when one questions the truth or falsity of a proposition. The fact is that many a proposition, as ordinarily announced, is little more than nonsense until in some way its field of application is made definite by suitable explanations.

The full significance of this principle can scarcely be overestimated. Failure to observe it has brought many of the annoying conflicts of opinions as held by different people. We habitually make assertions which are true enough as we mean them, true enough within a field of application in which our minds are just then operating. We fail in not making our statements locate the scope of our intended meanings, probably because we do not see, just then, that they may really have a more unrestricted field of application. Then our hearers or readers naturally take our statements as having the broadest possible application, or they locate them in some field of their own conception. In either case they deny their truthfulness. If a question of seeming importance is involved, an "argument" follows, consisting chiefly of opposing assertions understood differently by each party to the controversy. Each party is soon convinced of the stupidity or villainy of the other, personalities follow, and then any attempt at a mutual understanding is hopeless. Political differences have often grown up in this way. Theological

controversies, dividing millions of sincere adherents into hostile groups, may have had no other basis than just such misunderstandings as to the field of application of proclaimed dogmas. Even opposing schools of philosophy, where such misunderstandings would appear to be impossible, have had similar origins.

Plato taught that democracy was the basest form of government and yet Wilson asserted that, at whatever cost, "The world must be made safe for democracy." These two great authorities on political philosophy seem to have been hopelessly antagonistic. Were they?

Let those who undertake to carry on trains of thought by mutual effort, or participate in discussions, avoid this fatal blunder of using propositions with uncertain fields of application.

EXERCISE 10

Are there any fields of application in which the following propositions are true? If so, what are they? In what fields are they false, if in any?

1. Mountaineers are always freemen.
2. The sale of intoxicating liquor is prohibited.
3. The time between sunrise and sunset gradually increases during the month of March.
4. Taxes are levied on incomes.
5. Fortune has wings.
6. Cæsar is emperor at Rome.
7. All flesh is grass.
8. Napoleon was a genius.

9. Rent on any piece of land is that product which it yields over and above that yielded by marginal land for an equal expenditure of capital and labor.
 10. All's fair in love and war.
 11. Arbitration is the best method of settlement of disputes.
 12. The just shall live by faith alone.
-

Distribution of the Terms of a Proposition.—A proposition is an expression of a relation between two or more terms. Every term, as we have already noted, has its denotation, and when we use it in a proposition we must either refer to a part of its denotation or to all of it. In other words, the relation expressed by a proposition must involve either all of the denotation of terms used or a part. If the entire denotation of the term is definitely involved in the relation stated in the proposition, that term is used *distributively* and is called a *distributed term*. If only a part of the denotation of a term is referred to or if the extent of the reference is indefinite, that term is used *undistributively* and is called an *undistributed term*. In the sentence "Some men are republicans," the term "some men" is used undistributively since only part of the beings denoted by the term "man" are referred to. The term "republicans" is also used undistributively, since we are not saying anything about all republicans but only those that are referred to by the subject term "some men." That part of the denotation of the term "republicans" that constitutes the women republicans is not in-

cluded in the use here made of the term. Both subject and predicate, therefore, are undistributed terms.

In the sentence "The Pacific is a large ocean," the term "Pacific" is a distributed term. It is a proper noun denoting but one thing and a statement is made about that one thing. So the entire denotation is included. The term "large ocean" is undistributed. The whole denotation, that is, all large oceans, is not involved in the statement. Only one of the large oceans, the one called the Pacific, is referred to. Had the statement been "All oceans are large bodies of water," then the term "All oceans" would be a distributed term. The predicate term, "large bodies of water," would be undistributed, for the statement refers only to those large bodies of water that are called oceans. That term's denotation embraces in addition to oceans all large lakes, bays, etc.

In the proposition, "No human beings are immortal," the subject term, "human beings," is distributed, since the entire denotation is involved in their exclusion from "immortals." The predicate term, "immortals," is also distributed, since they are totally excluded from "human beings."

The above cases may be easily understood, but there is one case which requires particular attention. If the proposition were "Some apes are not anthropoids," while it is clear that the subject is distributed, the matter of the distribution of the predicate is a little obscure. It is evident, however, that no anthropoid can be included in that group of things

denoted by the subject term "some apes." That being true, the predicate term, "anthropoids," is being thought of as broadly as possible, that is, it is being used distributively.

EXERCISE 11

What are the subject-terms and the predicate-terms in the following? Which terms are distributed?

1. Some students are voters.
 2. All living things are (things that) have cells.
 3. No planet is a stationary body.
 4. Most monopoly prices are excessive (prices).
 5. Many automobiles are not six-cylindere (automobiles).
 6. Strawberries are ripe.
 7. Mt. Everest is the highest mountain in the world.
 8. Hydrogen is an inflammable gas.
 9. All Japanese are Mongolians.
 10. "Findin's is keepin's."
 11. Those flowers are not orchids.
 12. Brass is an alloy.
 13. Clocks are the best time keepers.
 14. Time and tide wait for no man.
 15. The Congress has adjourned and the members have all gone home.
-

Quality of Judgments and Propositions.—A judgment has been defined as an association in consciousness of two or more ideas and a recognition of a relation between them. A little observation will reveal that these relations are not always of the same kind.

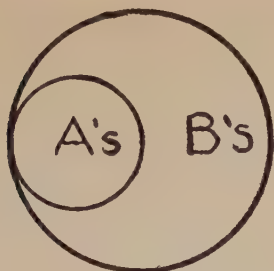


FIG. 3

The proposition, "All A's are B's" (Fig. 3) expresses a very different relation from that expressed by "No A's are B's." (Fig. 4.)

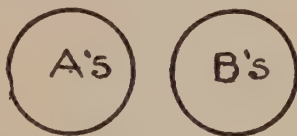


FIG. 4

In the last analysis, every relation between ideas must be either a relation of sameness, or difference, inclusion or exclusion, identity or non-identity. This characteristic of a proposition by which it identifies terms with one another or excludes them from one another is called its *quality*. The names given to the two kinds of quality are *affirmative* and *negative*.

Affirmative Propositions.—The quality of a proposition is affirmative if the relation stated between its terms is that of sameness, inclusion, or identity. In the proposition, "This ink is black," there is an affirmative relation between the terms "this ink" and "(a) black (liquid)." Also in the proposition, "Isaac

Newton is an Englishman," the relation between the terms "Isaac Newton" and "an Englishman" is affirmative.

Negative Propositions.—The quality of a proposition is negative when the relation between its terms is that of difference, exclusion, or non-identity. In the proposition, "No human being is infallible," the relation between "human being" and "infallibility" is negative. One is excluded from the other. In "This mountain is not 5000 feet high," the relation between "this mountain" and "(mountain) 5000 feet high" is negative in quality.

EXERCISE 12

Indicate the quality of the following:

1. Spring is almost here.
2. Not every person is uninterested in the ultimate progress of humanity.
3. Necessity is a good teacher.
4. No honest man every repented of his honesty.
5. Forbidden fruit is not always sweet.
6. No legacy is so rich as honesty.
7. All presidents of the United States must be citizens of the United States.
8. The road is partly paved.
9. A needle is never sharp at both ends.
10. The world must be made safe for democracy.
11. The first sentence of the Declaration of Independence.
12. The preamble of the Federal Constitution.
13. The Ten Commandments.
14. The Beatitudes.

Quantity of Judgments and Propositions.—When terms are associated together in a proposition, that association either takes in definitely all the denotation of the subject-term or it includes an indefinite part of that denotation. In the proposition, “All circles are round,” the entire denotation of the term “circles” is referred to. In the proposition, “Some circles are large,” not all the denotation of circles is involved—only an indefinite part, “some,” are included in the relation expressed. Recalling the explanation of the distribution of terms, we will notice that in the first example the subject is a distributed term; in the second, the subject is undistributed. This characteristic of propositions of using subject-terms distributively or undistributively is known as the *quantity of propositions*. When the subject is distributed, the quantity of that proposition is called *universal*. When the subject is undistributed, the quantity is called *partial*. (Called *particular* by some logicians.)

Universal Propositions.—The example given above, “All circles are round,” is a proposition universal in quantity, because the subject, “all circles,” is a distributed term. In the relationship expressed by the proposition, each and every circle is identified with round figures. Should we write “No circle is square,” we should have also a universal proposition. All circles, each and every one, by this statement are excluded from that group of objects known as “square figures”; consequently, the subject, “no circle,” is a distributed term.

On account of the ambiguity of language, judgment

must be exercised in determining the quantity of propositions. The following propositions, although alike in form, in fact differ in quantity:

All A's are not X's.

All ice is not liquid.

Every man is not honest.

All mountains are not snow-capped.

Strictly construed, the symbolic proposition "All A's are not X's" should be universal. It means that each and every "A", taken inclusively, is excluded from the "X's." Unfortunately, however, common usage permits it to be used to express "Not all A's are X's," or in other words, "Some A's are not X's," a partial proposition. Our knowledge of the facts involved leads us to accept the second example as a *universal proposition*. The third and fourth we regard as *partial* for the reason that our knowledge of the facts is more accurately expressed by "Not all men are honest," and "Not all mountains are snow-capped."

Only when "No A's are X's" may be substituted for "All A's are not X's," may we be sure that the latter proposition is universal in quantity. When our thinking is limited to the actual information conveyed by a proposition of this type we can never be sure that such substitution may be made. The only safe interpretation is to consider such propositions as partial.

In *singular propositions* the subject-term represents one individual. It may be a proper noun, as "Henry," "Africa," "the Rhine," or it may be a

common noun preceded by the definite article "the," or such words as "this," "that." Some examples of singular propositions are:

Chopin was a genius.

The boy is selling papers.

That book is interesting.

The Democratic convention was in session three weeks.

When the subject-term thus definitely designates one thing, that one thing constitutes the denotation of the subject-term, and any statement of a relationship using this subject-term must, of course, include its entire denotation. The subject-term, then, is distributed. The proposition is universal.

Singular propositions are always considered as universal except when the subject-term is a common noun preceded by the indefinite "an" or "a." "A great loss may prove a great blessing" is singular in form but indefinite in quantity. It is the indefiniteness of the designation that prevents such propositions from being regarded as universal.

Partial Propositions.—

Some young men are not trustworthy.

A few of the persimmons are ripe.

Quite a number of the delegates were present.

Many persons were injured.

The subject-terms, "Some young men," "A few of the persimmons," "Quite a number of the delegates," "Many persons," are all undistributed terms. Only an indefinite part of the possible denotation alluded

to is included in the relationship expressed between subject and predicate. These, then, are *partial* propositions.

Sometimes propositions are used that give no formal indication of their quantity. These are called *indefinite propositions*.

Republics are ungrateful.

Politicians are dishonest.

Mountain regions have little rainfall.

Our personal knowledge of the subject matter involved in these might justify us in considering them as universals. Nevertheless, they must all be classified with partial propositions because the relation expressed by them need be concerned with only a part of the subject. As a matter of fact, a relation universal in quantity may exist between subject and predicate, but that fact, if known to us, has been conveyed to us by some other means than the given proposition. While it may be that *all* republics are ungrateful, that knowledge is not conveyed by the proposition, "Republics are ungrateful." Since it cannot be assumed that indefinite propositions are universal, and, on the other hand, we may safely assume that all are partial, indefinite propositions are classified as partial.

EXERCISE 13

Classify the following as to quantity:

1. Each soldier carried his musket.
2. Not all warriors are brave.

3. Every life has its happy moments.
4. Many actors are underpaid.
5. No atoms are thoroughly understood by scientists.
6. Banks are safe depositories for money.
7. Studying is irksome.
8. Art is long, and time is fleeting.
9. Mount McKinley is one of the highest mountains.
10. None of the signals was observed.
11. Rashness is not always fortunate.
12. Pity is akin to love.
13. A black cat crossed his path ahead of him.
14. This bill is not constitutional.
15. Fascism is a novel political movement.
16. All oranges do not have seeds.
17. All the world loves a lover.
18. All the sheep are not of this fold.
19. All is not true that is told.
20. All successful men know how to hold their tongues.

CHAPTER V

TYPES OF JUDGMENTS AND PROPOSITIONS

There are three distinct types of judgments, and likewise, of propositions, each serving the process of thinking in its own peculiar way. These types differ, one from the other, in the manner in which they formulate and give expression to knowledge. They are known as *categorical*, *alternative*, and *hypothetical*.

Categorical Propositions.—When a proposition asserts a definite relation between its subject and predicate, it is *categorical*. “A is X.” “A is not Y.” “Ice is crystallized water.” “Some soil will not produce alfalfa.” “All truth is relative.” These are *categorical propositions*.

The categorical proposition expresses a judgment directly and without condition. It is therefore the most useful of the propositions and the one to which we strive, for practical purposes, to reduce the other two types. As indicated by the examples given, categorical propositions may be either affirmative or negative in quality and either universal or partial in quantity. They, therefore, fall into four groups. For simplicity and convenience these four forms of the categorical proposition are designated by the four capital letters *A*, *E*, *I*, and *O*, as shown below:

<i>A</i>	Universal affirmative:	All A's are X's.
<i>E</i>	Universal negative:	No A is an X.
<i>I</i>	Partial affirmative:	Some A's are X's.
<i>O</i>	Partial negative:	Some A's are not X's.

The typical categorical propositions may be represented by Euler diagrams, as shown below.

(*A*) All A's are X's.

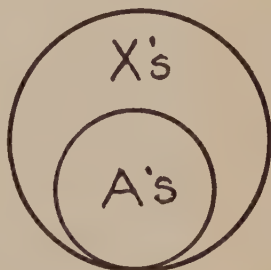


FIG. 5

“All salmon are fishes” is typical of *A* propositions represented in figure 5. If the subject-term becomes enlarged until it coincides with the predicate term, as “All triangles are three-sided figures,” the circles are made coincident.

(*E*) No A's are X's.

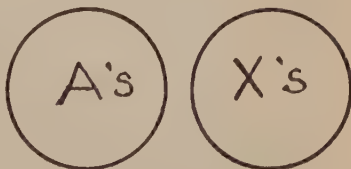


FIG. 6

Only one diagram can be drawn to represent the *E* proposition. (Fig. 6.)

(I) Some A's are X's.

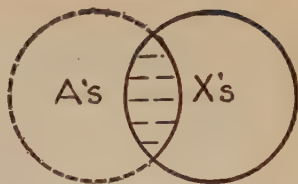


FIG. 7

The shaded section of the A circle (Fig. 7) represents that portion of the denotation of the subject, "Some A's," which is involved in this statement. The remaining denotation of A is uncertain and is therefore represented by that part of the circle enclosed by a broken line. This may be nothing or it may include all but one A. To represent such *I* propositions as, "Some fishes are salmon," the entire predicate term being included within the subject, draw the "X" circle wholly within the "A" circle.

(O) Some A's are not X's.

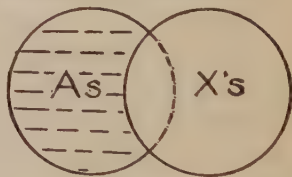


FIG. 8

The shaded section of the A circle (Fig. 8) represents that portion of the denotation of the subject, "Some A's," involved in this statement. The remaining denotation of A is uncertain and is therefore represented by that part of the circle enclosed by a broken line. This may be nothing, or it may include all but one A. To represent such propositions as "Some fishes are not salmon" draw the "X" circle within the "A" circle.

Alternative Propositions.—Often our knowledge cannot be expressed by a categorical proposition. It consists not of a definite, known relation between terms, but of an unknown alternative relation. When such is the case, an *alternative proposition* must be used. An alternative proposition is a proposition in which one or more alternatives are given, the choice of which may be in the subject, in the predicate, in both subject and predicate, or between two categorical judgments.

Either A or B is X. (Alternation in the subject.)

Either *Macbeth*, *Hamlet*, *Julius Cæsar*, or *Othello* is the greatest Shaksperian drama.

A is either X or Y. (Alternation in the predicate.)

The penalty for this crime is either fine or imprisonment.

Either A or B is either X or Y. *(Alternation in both subject and predicate.)

Either the doctor or the nurse was unskilled or negligent.

Either A is B or B is Y. (Alternation between two categoricals.)

Either he will be nominated or his followers will bolt the party.

The number of alternatives in an alternative proposition is not limited to two; any number may occur.

There is a certain ambiguity involved in the alternative proposition which it is important to understand. We are not quite clear when we are told

that A is either X or Y, whether it means that A is X or it is Y, *but that it is not both*, or that A is X or it is Y, *but it may be found to be both*. Much confusion and even serious misunderstanding have occurred because this ambiguity of language was not appreciated. The difficulty comes from our unfortunate habit of using one verbal expression for two different judgments. The logical use of an alternative proposition requires the assumption of the mutual exclusiveness of the alternatives.

"The signal for the attack will be given at either eight or nine," (*cannot be both*) "and the attack will be made by either the infantry or the cavalry" (*might be both*). This sentence contains two alternative propositions and illustrates both of these constructions.

The alternative proposition may be represented by a Euler diagram. The alternative term, the predicate by assumption here, should take the form of an ellipse cut in two by one or more lines separating the alternative terms. The related term, here assumed to be the subject, is represented by a circle with its uncertain location indicated by the fact that it is wholly included by a broken line.

All A's are either X's or Y's.

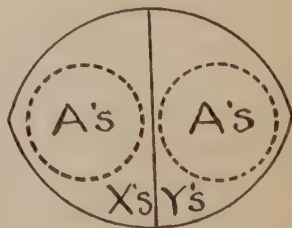


FIG. 9

As the A circle must remain within the ellipse, it must fall within one of the two component parts. It might fall part in one and part in the other, it is true, but, as has been observed, when such is the case the meaning of the proposition is too uncertain to have logical value.

Similar diagrams can be drawn to represent the other three kinds of the alternative proposition.

Hypothetical Propositions.—When our knowledge consists of two categorical judgments, one of which is dependent for its truthfulness upon the truthfulness of the other, the result is a hypothetical judgment, or when stated, a *hypothetical proposition*.

If A is X, B is Y.

If I go to the city, I shall not attend class.

When water goes below 32°, it freezes.

Electrical disturbances occur whenever sunspots increase in number.

Of the two parts of the hypothetical proposition, the one which gives the condition on which the other depends, or from which it results, is termed the *antecedent*; that part which is dependent upon the Antecedent is the *consequent*. In “If A is X, B is Y,” “If A is X” is the antecedent, and “B is Y” is the consequent.

The conventional form of the hypothetical proposition places the antecedent first in order, followed by the consequent, but this order may be reversed just as well. We may say, “There will be great destruction of property if war is declared,” as well as,

"If war is declared, there will be great destruction of property." The little conjunction "if" is the customary badge of the hypothetical proposition, but there are other words that serve as well. "When," "whenever," "should," "provided that," are examples.

Many known facts are transient, coming and going, appearing and disappearing. Careful statements about them must, therefore, be accompanied by the condition of their appearance. This calls for the use of the hypothetical proposition. "Crime increases when the laws are not enforced" states a permanent principle governing the relation between crime and its punishment. As an expression of the relation between possible phenomena, the hypothetical propo-

sition is indispensable. It becomes of more practical value, however, when it can be reduced to a categorical proposition. This process of resolving a hypothetical proposition will be explained later under hypothetical syllogisms. (See page 176.)

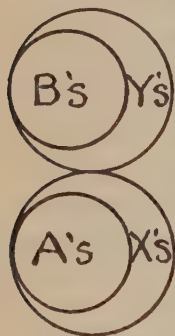


FIG. 10

As a possible aid in appreciating the nature of a hypothetical proposition, as "If A's are X's, B's are Y's," it may be somewhat fancifully represented by the accompanying diagram.

The antecedent, "If A's are X's," is represented by the two lower circles on which rests the figure representing the consequent, "B's are Y's." The logical dependency is symbolized by the support afforded the consequent by the antecedent figure.

EXERCISE 14

I. Classify the following as to type:

1. The appointment will be kept if train connections can be made.
2. Every man, woman, and child was counted.
3. That is either the president's or secretary's duty.
4. Climbing roses or honeysuckles will be planted here.
5. Temperature will fall when the sun is set.
6. If the constitution is not amended this bill can never become a law.
7. Either the Left, Right, or Main Road of Destiny had to be chosen by O. Henry's "David."
8. If the salt have lost its savor wherewith shall it be seasoned?
9. Wars are always destructive.
10. Good nature and good sense are usually companions.

II. Classify the following into *A*, *E*, *I*, and *O* propositions:

1. Roses are blooming.
2. All rivers flow into the ocean eventually.
3. Not every successful person is happy.
4. All condensed vapor does not make rain.
5. Texas is the largest state in the Union.
6. Generosity is a cardinal virtue.
7. Money is the fruit of evil as often as it is the root of it.
8. No one was killed in the explosion.
9. Anaximenes discovered condensation and rarefaction.
10. No taxation should be without representation.

11. The Eighteenth Amendment makes possible the Federal prohibitory law.
 12. No constitutional amendment has ever been repealed.
 13. Several countries have not joined the League of Nations.
 14. An increasing population may cause a grave labor situation.
 15. The prohibitory amendment to the constitution was not adopted as a temporary war measure.
-

Reduction of Propositions to Normal Form.—

For the sake of greater variety of expression or for more pleasing style, or perhaps because our thinking is not clearly done, we often state our propositions in a manner so lacking in simplicity and directness that their true meaning is not readily grasped, and error in thinking results.

There is still another reason, and it is an important one, why our language forms differ so far from the simple forms we have to use when we wish to be sure that our thinking is valid. Our lives are constantly changing, making our experiences so varied that they allow themselves to be expressed only quite inadequately by any language that we can command. Our language strives constantly, but somewhat ineffectively, to express these changing experiences. Most naturally, therefore, our language forever "deviates from the type." The rules for thinking cannot possibly provide for all these multifarious forms in language. They can deal with only the most simple forms. These complex language forms try to express

our complex experiences and we use them in our thinking, but the validity of such thinking must remain doubtful until our experiences and ideas are expressed in simple, less ambiguous language, such language as can be adapted to the technique of logic.

Whatever the form of any categorical statement, there is implicit within it a simple proposition having three parts: a subject, a predicate, and a copula. The order in which these parts fall, to make the meaning of the statement most evident, is

subject - copula - predicate

This is the *normal order*, as explained under "Normal Form of Propositions." When a proposition has been stated with its parts in any other order it is well—indeed, it is all but necessary—to rephrase it so as to get it into this normal form. It may then be admitted into a chain of reasoning which conforms to logical principles. In attempting so to reduce a proposition to its normal form, it is well to observe the following advice:

Find the idea regarding which the statement is made. This is the subject of the proposition. It may be difficult to isolate, but this must be done. Next find the idea to which the subject idea is related. This is the predicate of the proposition. Then determine whether the relation between the subject and predicate is affirmative or negative, and also whether the subject-term is distributed or undistributed. When this has been done, a categorical proposition may be expressed as an *A*, *E*, *I*, or *O* in

its normal form. For the copula, the present tense of the verb "to be"—"is" or "are"—must be used since other tenses give uncertain fields of application.

If a proposition is alternative, the same process may be followed in reducing it to its normal form.

If a proposition is hypothetical, a similar search must be made for the parts of the categoricals constituting its antecedent and consequent, and their mutual relationship as antecedent and consequent must be determined.

When Shakspeare wrote "All that glisters is not gold," he may seem to have been thinking about "all that glisters," but the sentence is absurd when that is assumed. He really meant to warn us that "some things that glisters are not gold." In this proposition "some things that glisters" is the subject-term, "gold" is the predicate term, and "are not" is the copula. Often the copula is discovered with difficulty. It may be merged into the predicate and then, to avoid confusion, it will have to be separated. A phrase, equivalent in meaning but beginning with "is" or "are," must be substituted for such a combined predicate and copula. This "is" or "are," sometimes accompanied by "not," is the true copula, and the remainder of the phrase is the predicate. Of course, great care must be taken in doing this or some change in meaning will creep in. "He cannot become rich who will not prosper" may be restated as "No one who will not prosper is one who can become rich." Here "is" is the copula; the part of the statement preceding it is the subject-term; the part following is the predicate term.

A few more examples of this process of reduction to normal form of propositions, as they are found in current use, may assist the student in doing what he must learn to do, and do rightly, when he undertakes to work out the precise meaning of a train of reasoning and to inquire into its validity. In the following the original form is given first, followed by the normal form as it may be used in a logical discussion:

1. "It is impossible to love and be wise."

To love and to be wise at the same time / is not / a possible human experience. (*E* proposition)

2. "He oft finds medicine, who his grief imparts,
But double griefs afflict concealing hearts."

This couplet from Spenser illustrates the complexity of phraseology indulged in by poets. It may be prosaically transformed into two separate propositions, which, however, are related by contrast: (a) Confiding grief / is / a means which often secures relief from it (an *I* proposition, because indefinite); and (b) Concealing grief / is / a means which often doubles it (also an *I* proposition).

In the foregoing examples the field of application is "human affairs" or "human nature" and it must be kept in the background of the thought.

3. "He jests at scars that never felt a wound."

All those that jest at scars / are / those who never were wounded. (*A* proposition)

4. "When the world is inclined to favor, it overrates as much as it underrates when it disfavors."

The degree to which the world overrates when it is inclined to favor / is / the degree to which it underrates when it disfavors. (*A* proposition)

5. "Nothing is more obnoxious than a low person raised to a high position."

The most obnoxious thing in existence / is / a low person raised to a high position. (*A* proposition)

6. "Blessed are the pure in heart, for they shall see God."

This makes two distinct statements: (a) All who are pure in heart / are / persons who are blessed, (*A*) and (b) All who are pure in heart / are / persons who shall see God. (*A*)

There is also a third assumption; namely, All who see God / are / blessed. (*A*)

7. Portia's reply to Shylock, "In the course of justice shall none of us see salvation," is a typical example of the distortion of propositions in common usage. And it is not quite clear what was uppermost in Portia's mind. Was she thinking primarily of justice as a factor in human destiny, or did she mean to say that the fate of all men was independent of justice? If the former, the proposition might be simplified by saying, "Justice / is not / an agency that will save any of us"; if the latter, it might be restated as, "None of us / is / a being who will be saved by justice."

8. "Every state will be delivered from its calamities when by the favor of fortune, great power unites with wisdom and justice in one person."

This is a hypothetical proposition of which the antecedent is "Whenever, in one person in a state, great power, wisdom, and justice are united," and the consequent is "that state will be delivered from its calamities."

9. "Let not mercy and truth forsake thee; bind them about thy neck, write them upon the table of thine heart.

"So shalt thou find favor and good understanding in the sight of God and Man."—*Proverbs* III, 2, 3.

This is a hypothetical proposition of which the first verse is the antecedent and the last the consequent.

10. "I die by the help of too many physicians."—*Alexander the Great*.

The cause of my death / is / help given by too many physicians. (A)

11. All flowers are not for nosegays.

Not all flowers are for nosegays.

Some flowers / are not / for nosegays. (O)

12. "Send a fool to market and a fool he'll return."

If a fool is sent to market, he will still be a fool when he returns. (*Hypothetical*)

13. "There is no need to fasten a bell to a fool; he is sure to tell his own tale."

All fools / are / people who betray their true nature. (A)

14. "None but the brave deserve the fair."

All men who deserve the fair / are / brave men.
(A) or, No coward / is / a man who deserves the fair. (E)

15. "What Heaven ordains the wise with courage bear."—*Homer*.

All those who are wise / are / persons who bear with courage whatever Heaven ordains. (A)

16. "Believe if thou wilt that mountains change their places, but believe not that men change their dispositions.—*Mahomet*.

The ability of mountains to change their places / is / an ability greater than that of men to change their dispositions. (A)

17. "No question is settled until it is settled right."

All wrongly settled questions / are not / finally settled questions. (E)

18. "After a long experience in the world, I affirm before God I never knew a rogue who was happy."—*Junius*.

No rogue / is / a happy person. (E)

19. "Fleets and armies are not always the strongest bulwarks."

Some things other than fleets and armies / are / stronger bulwarks than fleets and armies. (I)

20. "They always talk who never think."

All who never think / are / those who always

talk. (*A*) or, Talking / is not / evidence of thinking. (*O*)

EXERCISE 15

Reduce the propositions below to normal form when not so given and classify as to type. (a) If a proposition is categorical, state whether it is an *A*, *E*, *I*, or *O* proposition; (b) if alternative, tell what alternation is involved and where; (c) if hypothetical, give antecedent and consequent.

1. Rome was not built in a day.
2. He that falls in love with himself will find no rival.
3. No man can serve two masters; either he will hate the one and love the other or he will hold to the one and despise the other.
4. Lawyers and painters soon change white to black.
5. Blessed are the meek for they shall inherit the earth.
6. He lives in fame who dies in virtue's cause.
7. Repentance is the beginning of reformation.
8. Continued engagement in crime is certain to be detected.
9. An honest man is the noblest work of God.
10. When we have gold we are in fear; when we have none we are in danger.
11. It is great courage or great ignorance that carries us through great dangers.
12. Tears are sometimes as weighty as words.
13. Cast thy bread upon the waters for thou shalt find it after many days.
14. When my father and my mother forsake me then the Lord will take me up.

15. The love of power is an instinct of the human heart.
16. If all men were just there would be no need of valor.
17. Whatsoever a man soweth that shall he also reap.
18. He hath a good judgment that relieth not wholly on his own.
19. Out of sight, out of mind.
20. Make thy body thy servant, else it will be thy master.
21. He prayeth best who loveth best.
All things both great and small.
22. Men worship the rising, not the setting sun.
23. Who steals my purse steals trash.
24. A sharp sword, a clear head, or a stout heart, and the fight may be won.
25. Many talk like philosophers and live like fools.
26. A great talker never wants for enemies.

CHAPTER VI

TRAINS OF THOUGHT AND DISCUSSIONS

We have seen how two ideas may be combined through a recognition of their mutual relationship to form a larger unit of thinking, the judgment. In a somewhat similar manner, two or more judgments may be combined, resulting in another judgment, which in turn may be combined with others, and these with still others. Such a combination of judgments constitutes a *train of thought*. A train of thought, when expressed in language, is called a *discussion*.

A train of thought may be comparatively simple, or it may be indefinitely complex and elaborate; it may employ three judgments, or three thousand, or even more. By means of trains of thought we are able to make long journeys, so to speak, in our thinking, and to arrive at far-distant goals not even to be foreseen from the starting point.

We all engage in building trains of thought, but they are usually short ones, mainly because long ones are hard to construct and because we are afraid to trust our thinking very far.

Many people do not go, and do not want to go, on long intellectual journeys. They prefer staying near the old familiar facts. On these simple, familiar facts they are able to live with a degree of comfort.

They are saved from extreme forms of error by keeping close to realities that are verified by practical, everyday experience. Most of us are intellectual stay-at-homes who willingly take few chances because we are too stupid, too lazy, or too cowardly to do otherwise. But there must be intellectual pioneers. Some must dare to get out of sight of land. Some must be willing to risk the loss of the comforts of the old facts to win new fields of truth. Happily there have been such intellectual pioneers whose thinking has been a benefit to us all. Probably at no time in the history of the race were there so many as there are now. For long periods of time men who dared to indulge in unconventional thinking which took them into untried fields were restrained; they were penalized; they were poisoned, burned, crucified. This policy of restraining freedom of thought retarded and temporarily blocked civilization. Progress always has been possible—always will be possible—only where men are able and willing to follow their thinking into unknown regions in search of truth.

Logical Trains of Thought.—Whether we are intellectual stay-at-homes or are daring pioneers, it is extremely important that our trains of thought be as accurate and dependable as possible. A study of instances of successful thinking reveals several characteristics which should be observed in the construction of logical trains of thought. The English logician Welton has proposed four conditions which must be met to make thinking effective. These are:

1. *The purpose of thinking should be definitely and clearly conceived.*

Any attempt at earnest thinking is prompted by some motive for that thinking. Daily life is continually presenting specific problems with which our thinking is required to deal. Not only does some *purpose* prompt our thinking, but, if it is to be realized, that purpose must also guide and direct our train of thought. The more definite and clear the conception of our purpose, the better it can serve as a guiding factor.

When a train of thought has no such guiding purpose, it proceeds at random with little coherence and is rather a series of associated ideas than a train of consistent thinking. Such an experience may be entertaining but it affords no valid solution of specific problems.

2. *Data that are true and that are pertinent to the purpose must be chosen as a foundation for the thinking process.*

The choice of knowledge from which to proceed often presents most difficult problems. We must keep in mind the purpose of our train of thought and select those facts which have the most vital bearing upon it. They must be known facts, not mere suppositions. Otherwise we shall probably fall into error and all our efforts at thinking will be in vain.

Not only must our start be made from that which is *true*, but it must be *pertinent*, as well. The facts and principles chosen as the bases of a train of

thought must be such that the final conclusion is inevitable when the subsequent line of argument observes the principles of logical thinking.

In developing almost any train of thought, the material needed for your starting points is often not readily at hand. Data must be gathered by conducting other trains of thought—side excursions these might be called. In doing this, the thinker must keep in mind and be guided by both his original purpose and his sub-purpose.

3. Succeeding steps must be such that each follows necessarily from those which precede it.

Beginning with a definite purpose and using only what we know to be true and pertinent, we may go on toward a valid conclusion. To do so, we must proceed by logically related steps, or we shall be guilty of what is properly called “jumping at a conclusion.” When this principle is not observed, a conclusion, if it happens to be true, is not the result of our thinking at all but is just a fortunate accident.

Just what constitute “logically related steps” in an argument it is the function of the science of logic to determine.

4. The system should be well balanced, and as complete as is practicable for the purpose it is to serve.

Any system of knowledge, meager or elaborate, will be most useful when it is well balanced. By over-emphasis of some facts or principles within a field of knowledge, the system may be distorted and

the movements of thought within it may be less certain of reaching the proper goal. This balance within a given system is determined largely by the selection of the facts and principles accepted as its foundation.

If in writing a history of the United States a writer discussed only its wars—the battles fought, the number of men on each side, their arrangement in battle line, the number killed and wounded—and made little or no mention of peace-time activities such as economic conditions or social changes, his train of thought would be decidedly one-sided and out of proportion for his presumptive purpose—the writing of a history of the United States.

If we knew all truth, we believe that our knowledge would constitute one large, perfectly unified system. This system would be made up of many smaller systems. The aim of every science is the elaboration of such a system of all knowable truth existing in the field covered by that science. The construction of such systems of knowledge is the work of thinking, and the systems are products of trains of thought. In all fields of experience we are striving to construct systems of knowable truth. To the extent that we succeed in these efforts are we certain of the validity of our thinking within these fields.

Often our knowledge within a field of experience is too meager for us to build it into a complete system. Sometimes, too, our purpose is such that it is not important that our system be very elaborate. Sometimes a decision is so urgent that we cannot wait for the elaboration of much of a system. However, gen-

erally speaking, safety in thinking, the validity of conclusions, is enhanced by the possession and use of complete systems of knowledge employed in our thinking.

EXERCISE 16

Formulate simple and also elaborate trains of thought on each of the following questions:

1. Which candidate for a given office should be supported?
 2. In the selection of a profession what relative weight should be given to the economic, the social, and the spiritual values involved?
 3. The investment of a given small sum of money. Also a large sum.
 4. Acceptance or rejection of the theory of evolution.
 5. Manner of spending a holiday.
 6. Decision regarding the probable weather tomorrow.
 7. The historic significance of the battle of the Marne.
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Types of Trains of Thought.—In our attempts to indulge in trains of thought, as J. H. Robinson has pointed out, there are four general types, which may be helpful in an attempt to understand our manner of thinking, although they are not always distinctly separated one from the other.

Reverie.—The first and simplest type of such continuous thinking is what takes place in reverie, often termed “day-dreaming.” This is the favorite occupation of those whose minds are prolific but

purposeless. Most of us spend a large portion of our time in this sort of intellectual vagrancy. It may be that at such times, as one senator said of another, we "think we are thinking," but it matters little whether we are or are not, for such experience has value almost solely as entertainment.

Reverie consists of an undirected flow of images and ideas subject to the psychological laws governing the association of ideas. The customary delightful character of this kind of thinking is due to its being wholly free from the regulation of logical demands and it is concerned with a supposed world of facts not embarrassed by the real facts which we at other times have to recognize and submit to.

Rationalization.—Our thinking stiffens up and begins to give some direction to its proceedings when we are called upon to become responsible for some judgment we have adopted. We are then thrown upon our intellectual defensive. Then we choose our judgments with reference to their availability for such defense. And we arrange and marshal them so as to contribute to the apparent demonstration of our beloved belief. Thinking of this type may have a social motive, as when we wish to establish our claim to intellectual merit, if not superiority. It is used to convince others of what we wish them to believe. It is employed in the preparation of propaganda which is so common. This manner of thinking has been named *rationalization*, since it undertakes to provide conclusive reasons for a given proposition already announced.

Problematic Thinking.—A higher type of thinking

strives to attain desired ends by solving problems. The occasion for indulging in it is the appearance of a question which needs an answer. Here the goal is explicitly presented in the form of a question, and it is the task of thought to find the facts and principles, and so to relate them that the conclusion is attained and the problem resolved. Such thinking is said to be *problematic*. Daily life is replete with opportunities and obligations to engage in problematic thinking, more or less serious in their consequences, and more or less difficult of performance. It differs from rationalization in that it considers all sides of the question, while in rationalization a definite stand is taken which is to be defended or explained.

Creative Thinking.—This is a yet higher type. It is much more difficult than the others. In it the goal is a mere abstract ideal, possibly not clearly conceived, but assumed to be attainable. The facts and premises must here be chosen and woven together in such a way that a wholly novel conclusion inevitably follows. Creative thinking is the task of larger minds, seriously employed in improving the world as known. The work of the architect and engineer involves creative thinking. The artist is in a peculiar sense a creative thinker. Creative thinking is employed in statesmanship. A fine example of creative thinking was that which produced the League of Nations. For centuries good and thoughtful men had dreamed of a "Parliament of Man, a Federation of the World." All this time they had been thinking in the effort to conceive a practical organization of sovereign states. Their efforts finally culminated in

the League as organized after the World War. Hundreds of the greatest minds of the race contributed to this task, and even now it cannot be said to be completed. Before a really successful organization of the nations of the earth is fully created, the best thought of we know not how many more of the best minds of the race must make its contribution. All taken together, it will make an exhibit of creative thinking most imposing in character. It is by such united and prolonged effort that the noblest examples of creative thinking are produced.

Community of Thinking.—A train of thought may be the product of a single mind or of many. Few persons are able, alone, to carry out a long train of thinking with logical consistency because it will be broken down by diverting facts or ideas. This difficulty may be overcome in a measure by writing out the train of thought so that it can be critically revised; or it may be overcome partially by the co-operation of another person, the joint effort being conducted by conversation or even by correspondence. The combined effort of the two minds may tend to move more vigorously and more directly toward the chosen goal. Each person may bring a contribution of pertinent facts and may help prevent the argument from flying off on a tangent. Scientific research in a great many lines is being conducted by this kind of mutual assistance in the thinking which is the essence of such research.

It is probable that the presence of the social emotions tends to stimulate the intellectual processes. Several persons may participate in such a common

effort at effective thinking, each sharpening the wits of the others and helping to hold the train of thought to its first purpose. And there is no social experience more delightful than just such a community of congenial minds working together in the hope of developing a valuable truth.

Any number may take part in a case of community thinking; but there may be too many, and when there are, confusion and therefore futility of effort is almost sure to come. A public assemblage, engaged in the discussion of a serious question of practical moment, would furnish an example of this. Legislative bodies have found it necessary to have their most difficult work done by small committees. The quality of the results of the efforts made by "deliberative bodies" has often been such as to leave some doubt as to the safety of such community of thinking. Nevertheless, society has often found it preferable to individual thinking.

In a general sense, most thinking is a community matter. On most subjects of a general character we employ as premises for our individual thinking the conclusions of others who thereby participate in our thinking as we in theirs. Current report and traditional beliefs are built into our system of thought even without our knowing it.

What is known as "public opinion" is the product of this thinking together of the people. Democracy is largely the outgrowth of this preference for the thinking of numbers of untrained thinkers over that of the professional thinker who is in great danger of becoming a mere *doctrinaire*. This preference was

long ago expressed by the proverb, "In the multitude of counsellors there is safety."

He who thinks only in partnership with others tends to lose his initiative, his originality, his courage. He becomes a *conformist*. The solitary thinker, on the other hand, is in danger of developing idiosyncrasies and a narrowness that may even extend to bigotry.

Training in Thinking.—Since thinking—successful thinking—has such an important place in the conduct of our practical affairs, and since the thought of the untrained mind is so liable to result in error, it would be well if some means of training in thinking were available, and we should welcome any means of increasing our skill in that form of activity. Attempts have been made—many of them—to give skill in thinking to those who need and desire it. This problem of training in thinking has been a favorite subject for educational theorists. It is to be regretfully admitted that it has also offered opportunity for the educational charlatan.

Whatever method of training may be decided upon, it is beyond doubt that it must include practice in thinking. Many occupations require, in their successful practice, intense and prolonged efforts at thinking. Those engaged in them therefore get practice in thinking which tends to develop their native skill. The customary life of the student presumably compels participation in intellectual practice. The many studies embraced in the school curriculum all offer opportunities for such practice but in quite different degrees. One of the best of the college

disciplines is mathematics. In geometry, for example, the student starts with certain clearly stated facts and principles. With some of these he combines other known facts and proceeds by the observance of the established laws of thought to develop new facts and principles. These he again employs in combination with other known facts and principles and goes on inevitably to still other facts and principles. Thus he builds up a train of thought, giving him a system of truths which constitutes the great science of geometry. The student, when through, has followed a consistent, perfectly valid train of thought from beginning to end. He has had excellent practice in carrying on a train of thought. The materials he has employed have served his purpose as nothing else could have done better. He has observed the laws of valid thinking or has fallen into errors, easily detected. The question remains as to whether he has acquired skill in conducting trains of thought when he attempts to use other subject matter.

Since science is a system of thought as it is applied to a known field of facts, and in which the principles of valid, systematic thinking have been observed scrupulously, scientific studies, especially those based upon mathematical relations (because these relations are the most definite), afford splendid opportunities for training in thinking.

While practice is the first element in successful training in thinking, it is not the whole of it. It is not always true that "Practice makes perfect." Practice in *good* thinking only can make a good thinker. That is to say, that thinking should be

logical. It should follow the laws of valid thought. Practice of such thinking will develop skill in successful thinking, which in the opinion of many is the chief aim of all education. Practice in illogical thinking may only intensify and prolong the tendency to think erroneously and dangerously.

PART III
METHODS OF THINKING

CHAPTER VII

OBSERVATION; ANALYSIS; SYNTHESIS

The great psychologist, William James, said that to the baby the objective world is "one big, blooming, buzzing confusion." And he added, "That confusion is the baby's universe; and the universe of all of us is still to a great extent such a confusion, potentially resolvable and demanding to be resolved, but not yet actually resolved into parts."

Is this true? Confusion the world is, and not wholly resolved it is, also. But partly resolved it is, and increasingly so. For only by so resolving it can we know it, understand it, control it, use it. In this way do men fulfill the first commandment, to "subdue and have dominion" over the world.

The baby's blooming, buzzing, confused world gradually changes to a more quiet, orderly, accommodating one as he notes its several parts, arranges these in groups, and thinks about them by means of general principles.

To do this, the youngster must early learn to observe, to pay attention. Hardly that either, for some of the things reported by his sense organs are such as to attract his attention. He cannot resist their appeal, because they are such and he is such that they interest him inherently. If the baby is confused, he

is surprised and impressed, too. He has to make no effort to occupy his mind with certain things, and to ignore others. Rather, his mind *is occupied by* the interesting ones and not the uninteresting things which are for him as if they were not at all. And he will always be that way—he cannot help himself. On his last day as well as his first there will be interesting things and uninteresting things. But they will have changed in a large degree. Indeed, all through life this change will have been going on, so that when he becomes a man he “puts away childish things.” Growth in intelligence is due in large measure to this transfer of interest from one part of the multitudinous world of facts to another part.

All this has reference to native interest, that which requires no purpose or effort. But there is an artificial or acquired interest. To rise above the passive, unresisting life of mediocrity, one must take one’s native interest in hand and give direction to it. Literally he must *pay* attention to uninteresting things and refuse to be wholly occupied by the things having mere native attractiveness. This habit of attending to one thing rather than to another, and that with some conscious purpose, is called *observation*.

OBSERVATION

It is evident that observation, at least in its higher forms, is much more than mere passive perception; there must be recognition as well. Observation involves purposeful effort. There must be conscious selection out of a complicated situation and

estimation of importance of elements. This intentional direction of the process of observation is *thinking*, and in some cases it is thinking of a high order. The astronomer is quite properly said to be "conducting his observations" but he is thinking, too, and in a way more careful and more exacting than most of us often pursue.

Necessity of Observation.—While the process of observation goes on casually all the time, such observation is commonplace in character and serves us only in a commonplace way. A man observes the mud hole in front of him and steps over it thinking of something else at the same time. In driving a car, the matter becomes more serious and he hesitates and picks his way with deliberation around and among the chuck holes. Driving on, the roads grow gradually worse, the sky becomes overcast, road signs are scarce and uncertain in their directions; under such conditions the driver must be alert and much more observing than when all was going well.

Much more serious demands for effective observation are conceivable. Unsettled economic conditions may come. Ordinary business methods are disappointing. Failures grow more numerous and get closer home. Financial disaster seems to be impending. Now is the time to observe as never before. At such times, when great interests are at stake, individuals often give up their own posts as observers and turn to the advice of others who are thought to have superior ability to "read the signs of the times." "Expert observers," "professionals," "wise men," take over the direction of affairs and lead the people

to safety or ruin. Facts—facts of just the right kind—are all we want at such distressing times. No wonder that the educational charlatans, political demagogues, medical quacks are welcomed then, for they profess to be able to perceive the facts which are inscrutable to those of us who are in need of them.

Skill in Observation.—Skill in observing rightly is a great accomplishment. By it are the more important things in life revealed so they may be chosen and the unimportant ones discarded. We must acquire skill in observing the phenomena which have the greatest meaning and influence, and to do it not for their own sake but as means to some more remote end which is really to be desired. Superior skill in observation, therefore, results from ability to hold clearly and steadfastly in mind the goals sought, accompanied by those things which when known become effective means in the attainment of those goals.

Successful observation requires patience. Natural phenomena occur in accordance with natural conditions, not when any would-be observer is ready to observe them. And the significant ones are too often mixed with a mass of other phenomena for which the observer can have no use but out of which they must be rescued. The natural sciences require the most careful, intelligent, prolonged observation of the facts upon which they are built. Hasty observation, due to lack of patience, has many times misled well-meant effort into false by-paths.

Imagination Required in Observation.—Imagination plays a large part in observation, for good and

ill. The observer forms an image of that for which he is looking and when the thing appears, he recognizes it as he might not otherwise do. His danger is that the image he has formed may be quite unlike the thing sought, so that when the latter does appear, it is not recognized because it is so different.

Imagination may distort the facts observed; it may even manufacture them. Sometimes the image is so vivid that it is itself mistaken for the objective fact. Illusions, which afflict all of us at times, are such distractions. Hallucinations may come to few, but they come in most convincing forms.

Prejudice Corrupts Observation.—One of the greatest obstacles to successful observation is prejudice. This prejudice may be in favor of or opposed to some notion or theory. Through mere habit a notion gets firmly established and is dislodged with difficulty, if at all. Under its influence observation gets its facts discolored and distorted and is ignorant of the blunders it commits. When a belief has been harbored for a long time, and during that time has served as means of explaining facts which would otherwise have remained mysteries, such a belief almost completely closes our eyes to new but contrary facts. Through sheer familiarity, we are in danger of contracting an affection for old beliefs that it may be impossible to overcome.

On the other hand, we have many antipathies. These are ideas and theories for which we have contracted an aversion. These are probably more effective than our attachment to the familiar in blinding us to the facts we would otherwise observe.

Only the person who is determined to find the facts, regardless of their effect, will make a good observer. He who observes to obtain evidence to support a theory he loves, or to combat one he hates, will certainly fail as an observer. One who loves or hates a theory can hardly hope to see a fact—much less to search for it.

Charles Darwin, the prince of observers, early found that he could easily remember an observed fact which supported an old opinion, but could as readily forget one which was contrary to a favorite view. He therefore kept faithful records of all observed negative facts in order that he might be driven by them to discard erroneous views. There is no record of another devotion to the truth quite equal to his. How strangely his case stands out in the history of human thought—a history which is so largely an account of intellectual blindness.

Scientific Instruments.—Observation is aided in its more difficult undertakings by the employment of mechanical devices. The telescope gives man an increased range of observation, a million-fold greater than he had with his unaided eyes. The microscope does the same for minute phenomena. Scientific laboratories are filled with apparatus of every conceivable kind, designed to assist the investigator in continuing his attempts to observe the facts in nature which previously had been concealed from him. A scientific instrument embodies in practical form knowledge of a very definite character, and is therefore a means of coöperation of many persons of very diverse training and knowledge.

Modern science, and consequently the modern world, has become quite dependent upon scientific apparatus as an aid to observation, and in many matters progress in a science waits for the improvement of suitable apparatus.

ANALYSIS AND SYNTHESIS

Analysis.—The things which make up our world come to us as apparently complete wholes. A little consideration, however, shows that these simple things are really complex. A perfectly simple thing is rare, indeed, in our experience. A geometrical point might be an example, perhaps, and about the only one. A circle is seen to have many parts and characteristics; while an hyperboloid has so many that it would take a long time, and much effort, to become aware of them all.

As things themselves, apparently simple, become exceedingly complex upon inspection, so our ideas of them change from simple to complex ideas; and it is with these ideas we do our thinking, not the things themselves.

One of the commonest and most necessary acts of the intellect is that of breaking up these ideas into the elements composing them. This process of dissociating all the component characteristics of our ideas is what in logic is called *analysis*. Of the many characteristics thus derived, the essential characteristics constitute the connotation of the terms which represent the ideas we have been analyzing.

A work of art becomes the subject for analysis by unprofessional observers as well as professional

critics. Its more significant qualities may be easily detected, but there may be present subtle characteristics difficult of determination, and the best critics may disagree as to those which give to the work its peculiar merit. The book reviewer and the musical critic undertake to inform us as to the characteristics of the new productions in their respective fields.

Synthesis.—The process of analysis may be reversed. Having isolated and determined the component elements of an idea, they may be reassembled by another process of the intellect. This is *synthesis*. In this process of synthesis grouping the qualities or characteristics derived by analysis, it is possible to be guided by choice and to put together elements gotten from the analysis of more than one idea. Selected elements from any number of ideas may be so associated, if desired. The play of the imagination is largely just this, the reassembling of characteristics derived by analysis into new systems—"nearer to the heart's desire." There is no danger of overestimating the importance of this act of synthesis in everyday life. Art, in all its forms, is one of its results, as is invention, and the formulating of plans for future living of the individual and of society.

The student artist is expected to go through a long process of training in the analysis of the masterpieces in his art. He thus becomes familiar with the peculiar characteristics of the works of the masters. After such analysis he constructs his own contributions largely by the composition of the desirable elements of the works he has analyzed. This syn-

thesis of the characteristics of other things may result in a new object of merit, but it is a process of invention rather than artistic creation. A work of art is supposed to have original elements in it, although it is doubtless the product, to a large degree, of synthesis.

Contrast of Analysis and Synthesis.—More broadly, the term *analysis* is used to designate any act of the intellect which separates the component elements of any situation, however complicated it may be. *Synthesis* is given a similarly broad and practical signification—any act of the intellect which combines elements, however simple this combination may be.

Analysis is often, perhaps most frequently, conducted as a means of securing material for future synthesis. The natural sciences present innumerable examples of analysis and synthesis. Analytical chemistry, for instance, discovers constituent characteristics and thereby the ingredients of an enormous number of substances found in nature. The accurate knowledge obtained in this way is then utilized in artificially reassembling—synthesizing—the ingredients which have the known characteristics desired in the compound to be made. Practical difficulties place severe limits upon success in the manufacture of useful articles by such artificial synthesis, but surprising progress has been made. For most complex substances, the synthetic process of nature must yet be relied upon.

In every field of science, indeed in every field of human thought and endeavor, this process of analy-

sis and synthesis is going on and must continue to go on indefinitely. The detective's success depends upon intelligent synthesis based upon careful analysis. A criticism made of a young lawyer who seemed to be falling short of the brilliant career expected of him was that he failed in the analysis of his cases.

EXERCISE 17

I. Your watch stopped during the night. How can you use analysis and synthesis in deciding what to do about it?

II. Show how analysis and synthesis are employed in a team's attempt to profit by a football game lost early in the season.

III. How does a physician use analysis in the diagnosis of a case?

IV. A reporter is detailed to write up an event such as an earthquake. Does he employ analysis or synthesis, either or both? How?

V. Show how the constitution of a state is the product of a process of synthesis which followed a process, or many processes, of analysis.

VI. Indicate the analytic and synthetic steps taken by the weather bureau in formulating its meteorological predictions.

VII. A sociologist has a scheme for human betterment. Which did he use more in getting it, analysis or synthesis? If the scheme is visionary or impractical, in which of these processes does the fault probably lie?

CHAPTER VIII

CAUSE AND EFFECT

Causality.—Another method of thinking is based upon the relation between phenomena, known as *causality*. Phenomena do not come to our attention singly. Each one comes preceded by many others, attended by many, followed by many. Each phenomenon is but one of a cloud of phenomena. In the baby's "blooming confusion" of a world these aggregations of phenomena seem to be a chaos—just an accidental massing of happenings, each independent of the other. After a while observation reveals to the baby some order in these appearances. When it does, the baby's confusion is reduced, the chaos quiets down. Some phenomena appear repeatedly following certain others, and followed by certain others. Through habit the baby comes to expect them to continue to come to him in the order in which they have thus been coming to him. He notices that a phenomenon, K (bottle), appears following another, J (nurse), and followed by L (delicious taste), M (solid comfort), etc. When J does not appear, neither do the others. From this happening over and over again he naturally falls into the habit of thinking of them as certain to appear together and in this same order. It is but another

step for him to think of them as bound together inseparably.

As he grows older, the youngster finds that he can interfere with the continuation of such series of phenomena. Also he finds that when, by some act of his, one of a known series can be made to appear, it will be followed by the remainder of that series. Years of this sort of experience, filling the days as they pass, give the growing child a decided conviction that no event can occur unless it has been preceded by an antecedent event, known or unknown. This he falls into the habit of thinking of as its *cause*, and in time calls it by that name; the one which follows the cause is for him its *effect*. He may never understand just how a cause passes over into an effect, but he is very sure that an effect can never exist without its cause, nor a cause exist without its effect. This utterly indispensable relation between cause and effect has been called *Causality*. In the series above, K is the effect of J, and in turn the cause of L, and so on indefinitely.

Our habit of construing phenomena as causes and effects seems to be in obedience to the traditional dictum taught by the logicians which proclaims that "Nothing happens without a sufficient reason." It is so inexorable in its demands that it has been frequently regarded as something innate, axiomatic, that is, something which could never have come to us as the result of experience. What has been said above, however, is not in conformity with this belief.

Great differences of opinion regarding the nature of cause and effect have prevailed. The true nature

of cause is not easily perceived, nor is that of effect. Conflicts of opinion on this subject have come from attempts to agree upon a metaphysical interpretation of causality.

The beginner in logic need not concern himself with the problem of causality as such. It is more important that he should take a wholly practical view of the subject, since his purpose is to prepare himself to perform the practical task of finding causes for effects and effects for causes. We have no greater need of any knowledge than the knowledge of causes and effects, for by knowing causes we can often procure those effects that we want, and avoid those we do not want.

Kinds of Effects.—Analysis of phenomena as related causally to each other reveals the existence of two kinds of causes and two kinds of effects, different enough to call for separate treatment. Let us first consider phenomena as effects. Phenomena which interest us may be temporary or continuous. Sunset, the falling of a body, the explosion of a gun, the death of an animal, the battle of the Marne—are instances of temporary phenomena which we call *Events*.

The tides, the onward movement of a planet in its orbit, weather conditions generally, the migration of peoples, the rise and fall of prices, the thinking process itself—these are examples of phenomena which are continuous. Each of such phenomena we will call a *Continuum* (plural, *Continua*). Some continua, like the weight of bodies, are parts of the natural order of the universe and never cease so far as we are

concerned. Others endure for a longer or shorter period. Studied after they have ceased, these latter may be considered as Events; studied during their continuation, they must be thought of as continua.

Continua differ as to their constancy. Some continue without perceptible modification. These are called "states" and are explained as being due to inertia. The position of a mountain, the size of a metal bar as it was regarded by the ancients—these are examples of continua which do not vary perceptibly. Other continua are variable, increasing and decreasing in some perceivable manner. The size of a metal bar as moderns know it, the volume of a given quantity of mercury or alcohol, the birth rate and death rate of any people—these are examples of continua which go on indefinitely but which are forever changing in some appreciable manner.

EXERCISE 18

Classify the following into *events* and *continua*:

1. A bank failure.
2. The market price of coal.
3. The eclipse of the sun.
4. The continuous visibility from the earth of one side of the moon.
5. The French revolution.
6. The English revolution.
7. The change of the possession of the Philippines from Spain to the United States.
8. The position of the north star.
- [9. The evolution of the English language.

10. The origin of species.
 11. The equinox.
 12. The destruction of the Chinese Wall.
 13. Education of Henry Adams.
 14. The coming of spring.
 15. Signing of the Armistice.
 16. The inauguration of a president.
 17. The elevation of land masses on the earth's surface.
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Kinds of Causes.—In every case of effect there is a throng of attending phenomena from which one is chosen to be called the “cause.” The others which are regarded as having something to do with the effect are called “conditions.” The effect is actually a result of the combined influence of all the attending conditions. Nevertheless, one is picked out for the honorable post of cause. Which one? The choice often seems to be arbitrary. There is no rule to be stated for the choice of the cause, but that attending necessary phenomenon is usually designated as the cause which is near the effect in time and space, which is obvious, which is impressive, which is conveniently controlled, and which is well known. If any one of the conditions is strikingly active, it is likely to be selected as the cause. This selection of just one of the attending phenomena out of the list of recognized conditions is made to satisfy the wish for a practical means of controlling the effect. It comes from our desire to locate responsibility, and to gain the mastery over the phenomena which concern us.

As there are temporary phenomena, events, and

enduring phenomena, *continua*, considered as effects, so there are corresponding causes, differing accordingly. Some phenomena, regarded as causes, precede the phenomena regarded as their effects. They are said to be *antecedent causes*.—A cloudburst, followed shortly by flooded lowlands, is certainly to be counted the cause of the inundation. Then there are continuous phenomena which we ultimately, though not easily, accept as the causes of continua. These continuous phenomena are designated as *concomitant causes*.

The relation between the changing position of the moon and the tides offers a classical example of concomitant cause and effect. The continuous movement of the moon around the earth followed by a rise and fall in the surface of the ocean was doubtless observed by our prehistoric ancestors. Doubtless, too, they regarded one as the cause of the other; the exact reason for such a causal relation was then unknown to them—as it is still a mystery to us.

It is difficult to think of an event occurring in time before its cause, although we do have the idea suggested by a proverb which asserts that “coming events cast their shadows before.” This idea of anticipatory knowledge, called prophecy or prediction, seems to assume this sort of relation between cause and effect. It is more reasonable to construe it as knowledge of the earlier terms of a causal series, which have been found to be followed by the later terms of the series.

In the case of concomitant causes and effects the continuous cause is supposed to be occurring at the

same time as the continuous effect, although there often appears to be an interesting lag of the latter behind the former. The crest of the tidal wave comes some time after the passage of the moon over the vertical point, but this is easily understood.

When the effect is an event which has an antecedent cause, that phenomenon is assumed to be the cause which has appeared immediately preceding the effect. Whenever an intervening phenomenon is discovered between the hitherto accepted cause and its effect, this newly discovered phenomenon supplants in our judgment the old one as the true cause, and for us becomes its effect. This goes on indefinitely as long as finer analysis discloses previously unknown, intervening phenomena.

This may be made clearer by an example: The growing of clover has long been known to cause an increase of the following crop. Later it was found that the presence of certain bacteria on the roots of the clover was necessary to secure the expected results. Then it was found that these bacteria had the power of collecting and releasing nitrogen, and the presence of this nitrogen was then regarded as the true cause of the improvement in the productivity of the soil. Of course, it is not the mere presence of a leguminous plant, nor the customary parasitic bacteria, nor even the nitrogen, that causes the better crop to follow. It is the chemical process by which this nitrogen is incorporated into the structure of the growing plant.

Sometimes the alleged cause stands off quite remote from its effect, but in that case there is not

evident any intervening phenomenon, although there may have been abundant time for many such to occur. Any period of time may so intervene—centuries, even ages.

An example of such an enduring cause might be found in the study of earthquakes. These striking phenomena have always stimulated the human imagination to the attempt to find suitable causes for them. Not unnaturally the imagination has been influenced by ethical and even religious suggestions. Geologists now tell us that the earthquake is often the effect of a “fault” in the earth’s crust, formed, it may be, untold ages ago, and which has been there all this time unknown to the men who dwelt above, with no evident effect until the earthquake occurs.

EXERCISE 19

I. Give the conditions combining to produce the following phenomena as effects:

1. American Revolutionary War.
2. Starting of an auto.
3. Capitol Building at Washington.
4. Niagara Falls.
5. Poverty.
6. Mississippi River.
7. Rain.
8. Civilization.

II. Indicate which of the given conditions is to be chosen as the cause.

III. Classify into antecedent causes and concomitant causes.

MEANS OF DETERMINING CAUSES AND EFFECTS

Observation; Analysis; Synthesis.—In the search for the cause of a known effect or the effect of a known cause, each of the methods of thinking already described may be employed. Simple observation is followed by analysis and synthesis; observation furnishing the materials which may be taken to pieces by analysis and reconstructed by synthesis. Other means aid in determining causes and effects. These will be considered next.

Hypothesis.—Whenever we face a question to answer, a problem to solve, or a situation to unravel, we are apt to begin by making a guess and then using our guess as a basis for investigation and reasoning. This preliminary conjecture, held tentatively in mind while we test it, is a *hypothesis*.

Most frequently the problem which requires in its solution the use of a hypothesis is one involving causal relations. The importance of a hypothesis in determining cause and effect lies in its value as a basis, as a guiding purpose, for investigating and reasoning.

Even when a hypothesis fails to meet the test and must be discarded as false, the negative information it yields is not useless since from the wide range of apparently plausible causal relations there has been eliminated one possibility, and with this narrowing of the range comes higher probability of finding the truth later. It helps clear the ground, so to speak.

Many false hypotheses have stood severe tests for long periods of time and have even come to be

regarded no longer as hypotheses but as natural laws. Then newly discovered facts, which could not be denied or explained by the old hypotheses, ultimately overthrew them. New hypotheses, made to fit these new facts as well as the old, were conceived and accepted when they stood the test which destroyed their predecessors.

For ages men accepted the hypothesis of a world with a plane surface. But the day came when questions were asked of it which it could not answer. Then an opposing hypothesis, that of a spherically shaped world, entered into competition with it as a means of satisfying human intelligence. After centuries of warfare, carried on by disputation, the search for pertinent facts, the alignment and realignment of old facts, appeal to authority, the use of force, bloodshed, and the fire brand, the new hypothesis prevailed and now reigns supreme. From the present point of view, the story of this struggle between these two hypotheses seems incredible. But it is only one of many such stories that are only too true. A hypothesis of universal significance may in a day win its victory and a permanent place in the wisdom of the world, but it is more liable to take centuries.

As a hypothesis grows in favor, because it really works as a means of explaining the facts it concerns, it passes into the category of *theory*. A theory is merely a hypothesis that has won respectability of standing. Later, when it has passed the crucial test and stands accepted, it is proclaimed as a *law of Nature*.

The evolutionary hypothesis was conceived and proposed by the ancient Greeks. Until recent times it had few adherents. Darwin submitted so many facts that could be explained by it so much better than by any other hypothesis that it has been approved by biologists as a class. The time may come when the theory of evolution will be so successful as a means of explaining biological phenomena that no doubt as to its validity will remain. It will then properly be designated as the *law of evolution*.

Ability to formulate hypotheses is one of the marks of a scientific mind. This calls for an active, well-balanced imagination. But a true scientist will also know how to use his hypotheses. He will be merciless in the work he puts upon them. He will not form sentimental attachments for them. In fact, he will never fail to treat them as what they really are, mere devices for use as means to the acquisition of truth and the control of facts.

Experimentation.—Observation has been described as a method of acquiring a knowledge of those facts which manifest themselves to our perceptive organs. By its use enormous numbers of facts of the greatest consequence have been discovered.

By observation, combined with other methods of thinking, many causes are discovered and many effects. Indeed, some of the sciences, embracing vast systems of causal relations, are almost solely dependent upon it as a method of investigation. Astronomy, geology, and paleontology are such sciences. The social sciences are peculiarly limited to this method.

But Nature has chosen to conceal many of her most important facts. To get on in life beyond a low level, man had to come into possession of a great number of facts of Nature which were not available to simple observation. He therefore learned to set traps for Nature, forcing her to perform under conditions greatly simplified and wilfully chosen, to the end that she should give up her long-hidden secrets. This method of wringing Nature's secrets from her is *experimentation*.

An *experiment* is any planned arrangement of conditions under which a phenomenon is made to appear in order that its true character and its relation to other phenomena may be disclosed. By observation it was easily discovered that the length of the days varied, and in a regular manner, and that they pass through a quite uniform cycle which completes itself in three hundred and sixty-five days. But this method could never have revealed the law of falling bodies, the rate of travel of sound and light, or the way in which the blood circulates throughout the animal body. Experiment alone could do such things as these.

By observation it was discovered that water assumes three forms, and that each, under certain conditions, passes into the other; only experiment could have found out that other gases, like nitrogen and oxygen of the air, could assume liquid form.

Experimentation is widely employed as means of testing hypotheses that have been formed. In fact, experimentation cannot be carried on in the absence of a guiding, directing hypothesis.

Difficulty of Experimentation.—It has been shown that great skill may be acquired in observation, and that such skill is required in many cases of highest importance. But experimentation requires much greater skill. To anticipate in imagination the possible results of experimentation calls for much higher intelligence than observation requires. And to devise the experiment, to select from all attending conditions only those which may have some bearing on the problem, and to discard all others, is difficult indeed. Then to arrange the circumstances and means to be employed in the experiment so that actually the desired conditions will be present and no others—this is exceedingly difficult, at least in many kinds of experimentation.

Experimentation in Science.—Modern science uses experiment whenever it is possible to do so. Physics and chemistry are experimental sciences par excellence. Physiology tends to approach them, and it is followed by bacteriology, psychology, botany, and zoölogy, in this respect. Manifestly astronomy admits of no experimentation at all; neither does geology or paleontology. In astronomy, it is true, experiments are employed, but they are really experiments in physics, although they deal with phenomena involved in astronomy.

The impossibility of controlling large numbers of people and of using them for experimental purposes interposes a serious obstacle to successful experimentation in the social sciences. Masses of people will not submit to being used merely as means in a search for truth. Economics, sociology, and the

other social sciences, therefore, must continue to be predominantly observational sciences.

Conclusive Experiment.—Often experiments yield individual facts which suggest the existence of general laws, although these facts are not sufficient to establish the laws. However, there are other instances where even one experiment, because of its nature and the attending conditions, is absolutely conclusive and establishes beyond further doubt the existence of a law of nature. Such an instance of successful experimentation is called an *experimentum crucis*, that is, a crucial experiment.

When Langley built his aëroplane, now in the national museum, and tried it on the Potomac, he failed to prove the possibility of human flight because the experiment resulted in disaster. Nevertheless, the performance of the machine was such that Langley was convinced that flight by such a device would eventually be accomplished. Then the Wright brothers built a machine on much the same lines as those of the Langley machine. When put to the test, it rose from the ground on its own power and stayed in the air several minutes. Langley's trial made more plausible this theory but settled nothing. The Wright test was a conclusive experiment.

EXERCISE 20

I. What hypotheses might be found useful in an attempt to determine the cause in each of the following situations?

II. Is observation or experimentation used in the application of each?

1. A headache.
 2. An epidemic of typhoid.
 3. An unusually severe winter.
 4. The disappearance of a textbook.
 5. An increase in tax rate.
 6. The appearance of a ghost.
 7. The absence of popular interest in a political campaign.
 8. A general agricultural depression.
 9. A crime wave.
 10. Poor radio results.
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METHODS OF DETERMINING CAUSES AND EFFECTS

We often find, or think we find, the cause of a phenomenon without making any effort to do so. This is because we take the apparently preceding phenomenon as the cause and let it go at that. A clap of thunder, we could not fail to observe, was preceded by a flash of lightning. This, repeating itself frequently, convinced us that lightning causes thunder. Possibly so, but there is a good deal to think about before accepting it as an explanation if one is inclined to be thoughtful. But what causes the lightning? The clouds? And the cause of the clouds?

We have said that we want to know causes in order to control their effects. Then they must be selected with care, and such means must be employed as will bring certain results. A vast deal of consideration

has been given to the question of possible methods of finding out causes of known effects and effects of known causes.

Many methods have been proposed for determining causes. They may be reduced to two, corresponding to the two kinds of causes and effects. The first one, the Method of Antecedent and Consequent, is used to find the *antecedent causes* of events. The second one, the Method of Concomitant Variation, is used to find the *concomitant causes* of continua.

> **Method of Antecedent and Consequent.**—If the phenomenon whose cause is sought is an event and is preceded by other phenomena, these antecedent phenomena must be studied to determine which ones appear to be indispensable to the occurrence of the given event. By careful observation of numerous instances of the event and noting those antecedent phenomena which are always followed by it and are always present when it occurs, a judgment as to the practical cause can be formulated. The cause so located is an antecedent cause and it has been determined by means of the method of antecedent and consequent, the cause being the antecedent, the effect being the consequent. The fundamental principle upon which this method is based is that *the sole invariable antecedent of any phenomenon is its cause.*

An interesting instance of this method of discovering causes was the discovery of the cause of yellow fever. For ages that disease had taken human lives without number. Its appearance had been accounted for on the theories that it was caused by weather conditions, by effluvia from low, wet ground, by

demoniac agencies, by the mysterious dispensation of Providence, and by numerous other things. By the exact use of the method of antecedent and consequent, modern science at last discovered that yellow fever was caused by a specific organism in the blood stream, introduced by the bite of a mosquito within whose body the germ had passed through one of the stages of its development, but which had been gotten by the mosquito having previously bitten a patient suffering from yellow fever. It was a long, hard search, requiring the observance of the most rigid scientific procedure, but it succeeded at last.

Method of Concomitant Variation.—When the phenomenon whose cause we are seeking is a continuum, the preceding method is clearly inapplicable, since the effect is continuous and cannot be preceded by its cause. Some other method must be employed or the search for the cause must be abandoned. Again relying upon careful observation, it may be possible to discover some other phenomenon similar in its continuity to the effect being studied, that is, another continuum. Whenever careful and prolonged observation discloses the fact that these two continuous phenomena sympathetically change in some important respect, that is, that one changes as the other changes, it is fair to assume that one is the cause of the other. It may be possible, of course, that they are both effects of some third phenomenon, not showing itself but which is also continuous and varying as both of them vary. This method of discovering concomitant causes is called the *Method of Concomitant Variation*.

The changes of the seasons are examples of phenomena which have been successfully studied by means of this method of concomitant variation. The cause of price fluctuation has long been a subject of speculation. So many facts were present in such a complicated mass that nothing conclusive was established. At last it was noticed that as the supply of money varied, general prices also varied but inversely. Both prices and money supply were *continua*, so the method of antecedent and consequent could not be used. However, when the concomitant variation between the quantity of money and the general price level was established beyond doubt, the view that prices were causally affected by the money supply was accepted. In this instance, as in many others, the difficulty of discovering the true cause is enhanced by the presence of other continuous factors, also varying one way or another. Some of these are found to be supplementary causes of the phenomenon of price variation.

The first of the two methods described, The Method of Antecedent and Consequent, disclosing antecedent causes, may be more frequently applied than the second, The Method of Concomitant Variation, and it usually gives more positive results. The second may be employed only in those instances which involve phenomena having continuity of existence, but variability in some characteristic.

Continua that do not vary in any perceivable manner cannot be submitted to this method of concomitant variations for determining their causes.

There is no known way of investigating their causes. If we try to think of them at all we say their being and remaining what they are is due to inertia, which means nothing whatever.

EXERCISE 21

I. In determining the causes in the following, what method is used?

1. Your going to college.
2. Humidity of atmosphere.
3. Formation of a subterranean oil deposit.
4. An unexpected vote in congress.
5. Currency depreciation.
6. Varying length of time between sunrise and sunset.
7. Atmospheric pressure.
8. Subsidence of a small area of land.
9. Deflection of the magnetic needle.
10. Ocean waves.
11. The discharge of a revolver.
12. The lateness of a train.
13. The burning of a building.
14. Weight of bodies.
15. Winning the world series.

II. Of what other phenomena may each of the above be a cause or at least one of the conditions?

RESULTS OF DETERMINING CAUSES AND EFFECTS

Knowledge of Facts.—It has been shown that our most pressing needs are of facts which serve our immediate purpose in a practical way. Often we

have these facts within our possession and they are supplied on the instant by our memory. Often, however, we do not know the fact we have need of and we must find it or do without it. Not infrequently the fact we want is one involving the causal relation of two phenomena. If we are able to go through successfully with the process of determining this relation in the case in hand we acquire the needed fact and are satisfied.

Knowledge of Principles.—A principle has been defined as the embodiment in a judgment of many facts of a similar character. Knowledge of a principle brings potential knowledge of all these facts and makes them practically available if we are able to derive from the principle the included desired fact at the moment we wish it. The most useful of principles are those which state the causal relation between groups of facts as causes and groups of facts as their effects. These causal relations between such groups of facts, known as *empirical laws*, are to be determined by the methods explained for determining causes and effects.

NATURAL LAW

There are many kinds of laws. What is called a law may be a rule of action designed to govern the conduct of persons. If it has been adopted by political authority, it is *statutory law*, and is the foundation of government. *Divine law* is similarly conceived as the rule of human life in accordance with the expressed will of a Supreme Being. The object sought by such laws, conformity

in the lives of men, is attained by the application of some system of rewards and punishments, and by a sentimental regard for the law itself, or for the authority behind it.

That hypotheses may become natural laws has already been discussed. *Natural law* is a general term embracing all the laws of Nature. A law of Nature is ordinarily conceived as an active principle operating to secure the uniform occurrence of the phenomena observable in a certain realm of Nature. That bodies tend to move toward each other; that gases tend to expand indefinitely; that living things are like their ancestors—these are examples of laws of Nature.

Fortunately natural phenomena do repeat themselves with much observable uniformity. Were it not so, we should be inhabitants of Chaos. This consistent likeness in events is known as the *Uniformity of Nature*, which we fall into the habit of thinking of as the result of the working of natural law. Such a natural law as compelling cause of the occurrence of phenomena is really beyond our comprehension. As we actually know them, laws of Nature are but statements of our knowledge about these uniformly recurring phenomena, and are not their dynamic causes as is so often assumed.

When we have in mind the source of our knowledge of a law of Nature, we call it an empirical law, since it comes to us through our experience with the phenomena involved; that is, we derive it by inductive inference, to be explained later.

Many supposed empirical laws have been an-

nounced which later proved to be erroneous. Each generation has to revise its list of such laws as they were inherited from its predecessors. The extent of this intellectual house-cleaning has been so great, sometimes, that a serious skepticism has arisen as to the trustworthiness of all of the "Wisdom of the Ancients." The ability to discover and prove the falseness of traditional beliefs varies with times and peoples. When a people has lost its confidence to an unusual degree in the system of general propositions it has inherited, it has probably done so because of the influence of some extraordinarily critical and courageous individuals. When Kant first read Hume, he said, "I was aroused from my dogmatic slumbers." And Kant spoke for many people of his day.

It is interesting to note that a supposed empirical law may be false and yet may serve as a basis for thought even for a long period of time. That a theory thus serves as a foundation for thinking does not necessarily establish its validity. The belief that the earth was the center of the physical universe, the so-called *Geocentric Theory*, served as the background of the accepted cosmologies for ages, although it is now thought to be an absurdity, it having given way to the *Heliocentric Theory*.

EXERCISE 22

I. Give some laws of Nature and show how they involve causal relations.

II. Are the following hypotheses, theories, or laws of Nature?

1. Bad money tends to drive out good money.
2. Acquired characteristics are inheritable.
3. Water is the result of a combination of two atoms of hydrogen with one of oxygen.
4. The quantity of energy is constant.
5. Whatsoever a man soweth that shall he also reap.
6. War wastes the best blood of a nation.
7. Inoculation lowers the death rate by preventing disease contagion.
8. March is the month of winds.
9. The so-called law of diminishing returns.
10. Crime increases with density of population.
11. Gases vary inversely with external pressure.
12. Difficulty overcome strengthens character.

CHAPTER IX

IMMEDIATE INFERENCE

Inference.—Thinking has already been described as the mind in action, searching for knowledge, and using it. Thinking, so conceived, embraces many activities more or less different but often not easily distinguished one from the other.

The last method of thinking to be considered is what is called *inference*. It is the chief function of the science of logic to analyze and exhibit the various ways in which this process of inference can be successfully carried on.

By inference is meant that kind of thinking which starts with one or more known or assumed facts or principles and proceeds to derive from them some other fact or principle. Seeing a man run down the street with a policeman chasing him, we infer that a crime has been committed. The pseudo-weather-prophet who notices that the corn husks are heavier than usual infers that the approaching winter is to be unusually severe. Observing that the planet Uranus failed to follow its usual orbit led astronomers to infer that another planet, as yet unseen, existed beyond the orbit of Uranus and was drawing it outward. Years later this planet was discovered and named Neptune. These are examples of inference.

Inference takes on several forms which may be con-

sidered under two classes: Immediate Inference, and Mediate Inference.

It is apparently possible to derive a new categorical proposition from merely one other such proposition already in mind. When this is done, it is said to be a case of *immediate inference*. There are three types of immediate inference, namely: Conversion of Propositions, Obversion of Propositions, and Interrelation of Propositions.

Conversion of Categorical Propositions.—Every categorical proposition states the relation of its subject to its predicate. When this is known, what can be concluded about the reverse relation of the predicate to the subject? If all triangles are three-sided figures, are all three-sided figures triangles? When it is known that all poets are authors, can it be inferred that all authors are poets? This interchange of the subject and predicate terms of a proposition is known as *conversion* of the proposition.

Whether or not a proposition can be converted and remain valid depends upon the distribution of its terms. If subject and predicate are alike in distribution, their positions may be interchanged and the resulting proposition will remain true. If they are not alike in distribution this interchange cannot be made.

It is evident that if the knowledge given about any term involves only a part of the denotation of the term, as is true when the term is undistributed, it cannot be assumed to apply to all the denotation as when the term is distributed. It is self-evident that

whatever may be asserted of all of a class may be asserted of a part of that class. It is also self-evident that whatever may be asserted of part of a class may not for that reason alone be asserted of the whole class. As a consequence of the foregoing, when a proposition is converted without change in quantity, it is said to be an instance of *simple conversion*. When the quantity is changed, it is an instance of *conversion by limitation*.

Conversion of E.—In the *E* proposition, “No A’s are X’s,” both subject and predicate are distributed. Something has been said about every “A”; namely, that it is not an “X.” Likewise, something has been said about all “X’s”; namely, that there are among them no “A’s.” So from the proposition we may correctly draw the inference that “No X’s are A’s.” All *E* propositions may thus be converted simply.

Conversion of I.—In the *I* proposition, “Some A’s are X’s,” both terms are undistributed. In order that this statement may be true there must be at least some “X’s” that are “A’s.” “Some A’s are X’s” converts to “Some X’s are A’s.” The *I* proposition converts simply.

Conversion of A.—The *A* proposition, “All A’s are X’s,” has a distributed subject and an undistributed predicate. Since the entire denotation of the predicate “X” is not necessarily involved, there is nothing in the statement, “All A’s are X’s,” to warrant the conclusion that “All X’s are A’s.” An *A* proposition, then, may *not be converted simply*.

An *A* proposition does, however, convey some definite knowledge as to the relation of its predicate

to its subject. Although we cannot infer that because "All A's are X's," "All X's are A's," it is obvious that at least "Some X's must be A's." Hence the subject and predicate may be transposed on condition that the *quantity* of the proposition be changed to *partial*. Therefore, an *A* proposition can be converted only by making it an *I* proposition. It is converted by *limitation*.

Conversion of O.—The *O* proposition, "Some A's are not X's," has an undistributed subject and a distributed predicate. The distribution of the predicate of an *O* proposition is not easily recognized and will require careful consideration. In the illustration "X" is distributed because each and every "X" is excluded from the "some A's," designated by the subject. In order to convert an *O* proposition, an undistributed term, the subject, would have to become a distributed term, the predicate, in the new proposition. This, of course, would be making an assumption that is not warranted by the information conveyed by the *O* proposition. The *O* proposition, then, may *not be converted either simply or by limitation*.

The following table shows the distribution of terms within each of the four typical forms of categorical propositions:

<i>Proposition</i>	<i>Subject</i>	<i>Predicate</i>
<i>A</i> —universal affirmative	distributed	undistributed
<i>E</i> —universal negative	distributed	distributed
<i>I</i> —partial affirmative	undistributed	undistributed
<i>O</i> —partial negative	undistributed	distributed

A summary of the results of the formal conversion of categorical propositions is as follows:

<i>Given</i>	<i>Converts to</i>	<i>Method</i>
<i>A</i> —All A's are X's	Some X's are A's	limitation
<i>E</i> —No A's are X's	No X's are A's	simply
<i>I</i> —Some A's are X's	Some X's are A's	simply
<i>O</i> —Some A's are not X's	} not convertible	

EXERCISE 23

Give the *converse* of the following. (Reduction to normal form may be necessary.)

1. No *ex post facto* laws may be passed by Congress.
2. All United States treaties must be ratified by the Senate.
3. Numerous air mail routes have been established.
4. Wars occur frequently in the Balkan States.
5. A large portion of the world's population belongs to the Mongolian race.
6. The primary election plan has supplanted the convention system of nominations for many political offices.
7. Many persons are not in favor of the primary election plan.
8. Estes Park was once owned by an English earl.
9. No responsibility for starting the World War is welcomed by any country.
10. All debts do not incur the enmity of the debtor for creditor.
11. Every U. S. citizen twenty-one years of age may vote.
12. Sun spots vary greatly in size and number.

Obversion of Categorical Propositions.—A second form of immediate inference consists of the derivation of a new proposition by the obversion of the one given.

If we were to hear the statement, "All men are dishonest," we probably should infer from it that "no man is honest," without questioning our right to do so. This kind of change in propositions is known as *obversion*.

In the conversion of propositions, it will be remembered, no change in quality was permitted. In obversion the *quality is always changed*, but the relative positions of the subject and predicate terms and the quantity of the proposition remain as they were.

The following table shows the formal obversion of the typical categorical propositions:

A —All A's / are /
X's } obverts to E —No A's / are /
not-X's

E —No A's / are /
X's } " " A —All A's / are /
not-X's

I —Some A's / are } " " O —Some A's / are
/ X's } not / not-X's

O —Some A's / are } " " I —Some A's / are /
not / X's } not-X's

All circles / are / round No circle / is / a thing
that is not round

No oyster / is / a ver- All oysters / are / in-
tebrate vertebrates

Some apples / are / ripe	Some apples / are not / unripe
Some men / are not / in- corruptible	Some men / are / cor- ruptible

Since in obversion a negative proposition becomes affirmative and an affirmative becomes negative, it is clear that some other change must be made to counterbalance this change or the validity of the proposition would be endangered if not destroyed. This is accomplished by means of the familiar principle that "Two negatives are equivalent to an affirmative." When the quality of the proposition is changed, the *quality of the predicate term* is also changed, the two changes presumably neutralizing each other. To say that "some children are bright" would seem to say that "some children are not stupid."

A warning needs to be sounded in connection with the obversions of propositions. Such terms as "red" and "not red", "honest" and "not honest", leave no doubt as to their mutual exclusiveness. When we depart from the use of "not" to make the contrary term in the predicate and use instead such antonyms as *true—untrue; crazy—sane; honest—dishonest; swift—slow; cold—hot*; such terms may fail to cover the whole ground and the inference would be invalid.

The change in the predicate must be such as exactly to counterbalance the change in the copula. If we say that "Some A's are X's" means the same as "Some A's are not not-X's," we do so because the two *nots* are identical, but we would hesitate to affirm that the

statement, "Some men are prohibitionists" has the same meaning as the statement, "Some men are not anti-prohibitionists."

Explained in another way obversion involves a classification in which a genus has been divided into two species. One of these species is the predicate of the given proposition; the other is made the predicate of its obverse, and if a subject-term is classified in one of these species it is excluded from the other. This classification must observe the rules of a logical classification if true obversion results. For instance, we cannot say that because no Fourth-of-July is cold, therefore all Fourth-of-July's are hot, for the species "hot" and "cold" do not constitute the entire denotation of a genus—there is a middle ground of cool and warm.

EXERCISE 24

Give the obverse of the following: (Reduction to normal form first is advisable.)

1. Insurance is increasing in the U. S.
2. Music hath charms to soothe the savage breast.
3. Thales believed that the earth floats on water.
4. Haste makes waste.
5. To doubt is to fail.
6. The heart is wiser than the head.
7. Roses do not grow on thistles.
8. Stone walls do not a prison make.
9. All philosophy begins in wonder.
10. No system works perfectly.
11. No active volcanoes are in the United States.

12. Not every convicted person is guilty.
 13. All national banks must be members of the Federal Reserve System.
 14. The Federal Reserve System provides an elastic currency.
 15. Savonarola defied Rome.
-

Inter-relation of Categorical Propositions.—Categorical propositions have been classified according to their quality and quantity. The resulting four types, the *A*, *E*, *I*, and *O* propositions, have definite relations to each other, such that the knowledge of the truth or falsity of one may imply the truth or falsity of others.

Each of these typical propositions, being in turn assumed to be true, and then assumed to be false, true and false propositions can be derived as follows:

The A Proposition Assumed to Be True.—If it be accepted that “All the senators were in their seats,” it necessarily follows that the corresponding *E* proposition, “No senator was in his seat,” must be false, since it is self-evident that the propositions cannot both be true. The corresponding *I* proposition, “Some of the senators were in their seats,” is true, since it is included in the universal affirmative, the *A* proposition, which was assumed in the beginning to be true. The *O* proposition, “Some of the senators were not in their seats,” cannot be true, since it contradicts the *A*. Since all the senators are included in the list of those about whom the remark was made, it is contradictory to say that some of them were not.

The A Proposition Assumed to Be False.—Suppose we find that “All the money was stolen” is false but

know nothing more about it. We would then have an *A* proposition known to be false. The corresponding *E* proposition, "Not any of the money was stolen," might be true, for then the given proposition would be false as it is assumed to be. The *E* might also be false if only the *O*, "Some of the money was stolen," was true. We therefore conclude that when *A* is false, the truth or falsity of *E* is unknown. The *O* proposition must be true, for otherwise the *A* given as false would be true. Also the corresponding *I* is left in doubt, because if it were false, *A* might be false, and also if it were true, the *A* might be false. Therefore, when *A* is false, we do not know anything about the corresponding *I* proposition.

The I Proposition Assumed to Be True.—Should our knowledge of the subject be limited to the statement that "Some of the apples are ripe," we know that the truth of the corresponding statement, "All the apples are ripe," is uncertain, because the *A* might be true when the *I* is true and also it might be false. The *E*, "None of the apples is ripe," is, of course, false. The *O*, "Some of the apples are not ripe," is uncertain. The fact that some of the apples are ripe carries with it no information regarding the others. They may be ripe or unripe.

The I Proposition Assumed to Be False.—Some of the persons in a wreck are reported to be killed, but the rumor is denied on good authority. In that case, we start our reasoning from the knowledge that the *I* proposition, "Some of the persons in the wreck are killed," is false. Following the same line of thinking

as we did above, we would find that the three corresponding propositions, *A*, "All the persons in the wreck are killed," is false; *E*, "None of the persons in the wreck is killed," must be true; and that *O*, "Some of the persons in the wreck are not killed," would be true.

The E Proposition Assumed to Be True.—Accept as true that "No parabola encloses space," and it follows, pursuing the same line of reasoning, that *A*, "All parabolas enclose space," is false; *I*, "Some parabolas enclose space," must be false; and *O*, "Some parabolas do not enclose space," would have to be true.

The E Proposition Assumed to Be False.—"No taxes levied are general property taxes." Let this be assumed to be false. The corresponding *A* proposition, "All the taxes levied are general property taxes," would be true or false according to whether or not only some of the taxes were general property taxes. The proposition, "Some of the taxes levied are general property taxes," would be true; and the *O*, "Some of the taxes levied are not general property taxes," would be doubtful.

The O Proposition Assumed to Be True.—If the *O* proposition be given as true, "Some politicians are not statesmen," the corresponding *A*, "All politicians are statesmen," could not possibly be true; *E*, "No politicians are statesmen," would be doubtful; and *I*, "Some politicians are statesmen," would also be uncertain.

The O Proposition Assumed to Be False.—Let it be assumed that "Some of the candidates are not eli-

gible," is not true. It is apparent that the *A*, "All the candidates are eligible," would be true. From this it would follow that the *E*, "None of the candidates are eligible," would be false, and the *I*, "Some of the candidates are eligible," would be true.

Graphic Presentation.—This inter-relation of the four typical categorical propositions, *A*, *E*, *I*, and *O*, constitute an interesting system. These relations are sometimes graphically exhibited by a geometrical diagram (Fig. 11) that has come down to us from Aristotle.

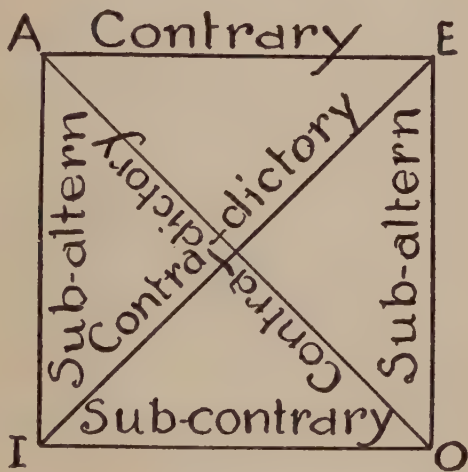


FIG. 11

The two universals, *A* and *E*, differ in quality and are called *contraries*. The particulars, *I* and *O*, also differ in quality and are called *sub-contraries*. The partial *I* is the *subaltern* of its universal, *A*, as *O* is of *E*. In these pairs the difference is that of quantity.

A and *O* are *contradictories*, as are *E* and *I*. Contradictories differ in both quality and quantity.

The two diagonal lines in the attached diagram connect the two pairs of contradictory propositions, *A—O*, *E—I*. If one of the members of either of these pairs is true, the other is necessarily false; and if either member is false, the other must be true.

The four side lines differ from the diagonal lines in that they represent no such vice-versa relations. Of the contraries, *A—E*, if either is true the other must be false, but if either is false the truth or falsity of the other is left uncertain. Just the opposite relation exists between the sub-contraries *I—O*. If either of them is false, the other must be true, but if either is true, the truth or falsity of the other is uncertain.

The relation between a universal and its subaltern is that if the universal is true, its subaltern must also be true; and if the subaltern is false, its universal must be false. Also, if a universal is false, its subaltern is uncertain as to truth or falsity, and if the subaltern is true, the truth or falsity of its universal is uncertain.

By generalization the following rules will be found to apply:

When *A* is true, *E* is false, *I* true, and *O* false.

When *E* is true, *A* is false, *I* false, and *O* true.

When *I* is true, *A* is doubtful, *E* is false, and *O* is doubtful.

When *O* is true, *A* is false, *E* is doubtful, and *I* is doubtful.

By assuming the falsity of each in turn, a similar table shows that:

When *A* is false, *E* is doubtful, *I* is doubtful, and *O* is true.

When *E* is false, *A* is doubtful, *I* is true, and *O* is doubtful.

When *I* is false, *A* is false, *E* is true, and *O* is true.

When *O* is false, *A* is true, *E* is false, and *I* is true.

Certain general principles are to be noted:

(1) The truth of either universal carries with it the truth of its partial or subaltern, the falsity of its contrary, and the falsity of its contradictory.

(2) The falsity of either universal implies the truth of its contradictory, but leaves its contrary and subaltern doubtful.

(3) The truth of a partial makes its contradictory false, but leaves its universal and sub-contrary doubtful.

(4) The falsity of a partial carries with it the falsity of its universal, the truth of its contradictory and of its sub-contrary.

(5) The doubtfulness of a proposition carries with it the doubtfulness of its contradictory.

By employing the foregoing general principles one may increase one's comprehension of the actual meaning of propositions and be able to supply those most useful in conducting an investigation or refuting an argument. While it is, of course, possible to com-

mit these tables to memory, it is much better to be able to reason them out as needed. The student is urged to familiarize himself with this subject of the interdependence of the typical propositions.

EXERCISE 25

I. Classify the following as to whether *A*, *E*, *I*, or *O* propositions.

II. Give the corresponding propositions for each and the inferences that may be made as to their truthfulness.

(a) Given as *true*:

1. All cats are felines.
2. Some soils are not productive.
3. Eye glasses may do more harm than good.
4. No alcoholic liquor may be sold in the United States.
5. France has a republican form of government.
6. All continents have primary axes.
7. Gold is the best basis for currency.
8. No criminal is really successful.
9. Marco Polo was an explorer.
10. Many books are of little value.

(b) Given as *false*:

1. No alcohol is sold in the United States.
2. Laborers do not deserve wages above the margin of subsistence.
3. All Frenchmen desire the depreciation of the franc.
4. Noah was given the Ten Commandments on tables of gold.

5. Some presidents of the United States have served three terms as president.
6. No reputable scientist denies the evolutionary theory.
7. Some comets traverse circular orbits.

CHAPTER X

MEDIATE INFERENCE—ANALOGICAL REASONING AND INDUCTION

Mediate Inference.—Mediate inference differs from immediate in that the new knowledge is inferred from two or more judgments, called *premises*, instead of only one. For example, let it be accepted that all on board a wrecked steamer went down with it. Later it is found that a certain person, M., was a passenger on the unfortunate vessel. Quite properly it would be inferred that M. was dead.

Of course, the validity of the conclusion in mediate inference depends upon the truthfulness of the judgments from which the inference is drawn, although the conclusion might be true when the premises were false, but for some other reason. The validity of mediate inference is also dependent upon the observance of several logical principles yet to be discussed.

The list of forms of mediate inference include Analogical Reasoning, Induction, and Deduction.

ANALOGICAL REASONING

Analogy.—Whenever there is found to be any similarity or resemblance between two things or two groups of things, there is said to be an *analogy*.

between them. They are analogous to the extent to which they resemble one another. If two things were identical, they would be completely analogous. Analogy is any similarity or resemblance of two things because they possess similar properties or relations. There is analogy between a current of water flowing through the land and another flowing through the sea, which is the reason they are both called streams. A somewhat similar movement of a group of human beings is spoken of as a "stream of people."

Reasoning by Analogy.—Man has been greatly aided in his task of understanding the world about him, especially in early life, by his ability to perceive analogies. But he is not satisfied with only the obvious in his universe. He is eager to find out the unapparent and the unknown. By furnishing a basis for his reasoning, analogies aid him in doing this.

Because some new object resembles a familiar one, the child calls it by the same name. And he does this because he has reasoned analogically.

We are selecting a book and want something light and humorous. *The Connecticut Yankee at King Arthur's Court*, by Mark Twain, is proposed. We remember reading *Huckleberry Finn* by that author. It was humorous. We infer that this book also is humorous and so select it. The analogy between these books is that each was written by the same author. The inference from this analogy is that since one is humorous the other is also.

This basing of conclusions upon analogy, as in the above instances, is called Reasoning by Analogy or

Analogical Reasoning. It may be based upon one analogous characteristic or upon several. Symbolically expressed, we may reason by analogy that *C* is like *D* in *r* because we know it to be like *D* in *l* *m*, *n*, and *o*.

The familiar story of the discovery of the law of specific gravity by Archimedes illustrates analogical reasoning. That light travels in waves was first suggested through the use of reasoning by analogy. It was known that sound traveled in such manner, and because of the similarity in their reflective qualities, it was inferred that the method of travel was the same. This hypothesis based on analogy was tried out and proved to be true.

Lawyers and judges make much use of reasoning by analogy. Decisions are justified and pleas are made on the ground that in some analogous case similar decisions or interpretations were made.

Presupposition in Analogical Reasoning.—The validity of any conclusion based upon reasoning by analogy must always be uncertain. This is due to its being based upon the supposition that because two things are alike in one or more known characteristics, any characteristic known to be possessed by either will be found to be possessed by the other. This, of course, is fallacious. Two things need not be alike in any unknown respect merely because they are alike in some known respect. For instance, from the fact that two automobiles are alike in that they were made at the same factory, it does not necessarily follow that they are alike in respect to number of cylinders.

Since analogical reasoning can furnish no conclusive assurance of validity, the question is naturally raised as to why it should be so much used. Hypotheses, as the reader will recall, are guesses held tentatively in mind while they are tested. The reader will also recall that they are necessary as a basis and guide for investigation and discovery. Analogy serves as a basis for these hypotheses. We draw *working* hypotheses from analogous past experiences by means of analogical reasoning.

EXERCISE 26

I. For each of the following terms give another possessing some analogy:

- | | |
|--------------|-----------|
| 1. Head | 6. Storm |
| 2. Carpet | 7. Sea |
| 3. Pencil | 8. Chain |
| 4. Salt | 9. Sphere |
| 5. Childhood | 10. Watch |

II. By analogical reasoning derive some proposition from each of the following:

1. Miss Ederle swam the English Channel.
2. Whitman discarded rhyme and rhythm and wrote great poetry.
3. Cæsar had his Brutus.
4. Smith's apartment paid him 20 per cent. net profit last year.
5. That Franklin makes twenty-four miles per gallon.
6. The leaning tower at Pisa has stood 750 years.

III. Give propositions from which the following might have been derived by analogical reasoning:

1. Mary will have the whooping cough.
2. This Emerson pen will give me good service.
3. The artist Bailey should be given the commission for the projected statue.
4. *As You Like It*, to be given by the Ben Greet Players, will be well worth seeing.
5. Modern Greece and Egypt will have glorious careers.
6. The Chinese are liable to develop into a military people.
7. Mexico will never be successful at self-governing.
8. Your typewriter should give you good service.
9. Nevada will in time become a great state.
10. The earth will some time be too cold to permit life.

INDUCTION

Through many centuries, the so-called "dark ages," the efforts of thoughtful men made no appreciable progress toward the increase of the race's knowledge of facts. Scholastic philosophy devoted itself to the keenest kind of thinking in defense of propositions which had come down to it and which it accepted on the ground of authority. Among the schoolmen there were many of the greatest logicians, but the results of all their disputations were quite barren of new truth, without which any sort of progress in civilization is impossible. The authority which provided the premises with which men thought denied to them the right of employing them in the search for new truth. The type of thinking of that long period was largely rationalization.

The human intellect could not permanently submit to such slavery. At last it broke away and proclaimed its right and determination to find out anything and everything in the whole universe that could be found out. This started a new epoch in civilization.

Scholastic thought had concerned itself with general formulas and seemed indifferent to mere facts. A general principle may be true enough but you never can be sure of it except by an appeal to the facts involved. It is easy to say and believe, for instance, that an infinite number of angels can dance on a needle's point, but it is difficult to prove. That it was difficult to disprove was a reason why the doctrine lasted as long as it did. After all, it was not a matter of great consequence, not nearly so important as the plagues which swept over the world time and again, taking millions of victims.

Realization of the value of knowledge of facts, making possible their control, is the peculiar keynote of modern thought. General principles, laws of Nature, have been formulated and rigidly verified by present-day science as never before, but they are most highly appreciated as means to useful facts, not for themselves alone.

The method of reasoning adopted by the originators of the so-called "Baconian Method" was one which starts with facts, not general principles. It is named *Induction*. When thought starts from general principles, it is called *Deduction*.

Induction starts where observation has furnished it a starting point. Observation systematically

seeks facts as such, and records their presence and their nature. Induction is thinking from these known facts on to a general principle. If the thinking moves from one fact directly to another fact, the process is *Reasoning by Analogy*, already described.

The object of induction, it is apparent, is the derivation of empirical laws, embracing under their sway a great number of facts. Knowledge of such empirical laws gives potential possession of all the facts embraced under them in a form available as material for future thinking, and the expectation of control of those facts by means of those laws is the motive in the search after them.

Induction a Form of Inference.—It should be kept in mind that induction is a form of inference. It is not mere substitution of a general statement for several individual statements embraced under it. Such a summary statement, sometimes called “perfect induction,” is not induction at all, since it consists merely of the observation that each and every individual of a class possesses a certain characteristic, and then the assertion that all the individuals of the class possess it. There is nothing at all new in such a conclusion; in fact, there is no conclusion whatever. There is merely a general statement embracing as many individual statements as there are individuals in the class. In true induction the general conclusion must cover more facts than have been considered individually in the process of induction from which the conclusion was derived.

When a jury of twelve men has been polled and one

after the other, from the first to the twelfth, votes for the verdict, there is no inference involved in passing from these twelve facts to the general statement "All the members of the jury favor the verdict."

During a political campaign a poll is sometimes taken of a relatively small number of voters and the returns are considered an indication that the entire electorate is divided in the same way as are those who have been included in the poll. This is a clear case of inferring a general conclusion from knowledge of a small number of instances embraced within the conclusion and is an example of induction.

There are two kinds of induction. They are Induction by Enumeration, and Induction by Essential Characteristics.

Induction by Enumeration.—General statements such as "All A's possess r's" are often accepted with little consideration as to the necessity of the characteristics they assert. Symbolically expressed, such reasoning may be in this manner: This A possesses the characteristic r; therefore all A's possess r. Should the investigator be less credulous, more cases might be observed as A1, A2, A3, A4, and found to possess r. From this the same general conclusion might be inferred, "All A's possess r." When the general conclusion is thus based on the merely observed, unexplained fact that since some of the individuals of a group possess certain characteristics, all do, the process of reasoning is called *induction by enumeration*. Any number of individuals may be included in the enumeration upon which a conclusion is based. According to the law of probability, the

greater the number of individuals included, the greater the chance of the truthfulness of the general conclusion regarding the entire group. But absolute assurance of its accuracy is reached only when every individual of the group has been examined for the characteristic in question, and then the general statement ceases to be the result of inductive inference. It is a mere summary statement of observed facts, as already explained.

We may examine half-a-dozen books on a shelf and find that each is written in French and from that infer that all the books on that shelf are written in that language. This is an example of induction by enumeration with a conclusion obviously doubtful. If we examine each book on the shelf and find that it is French, we can generalize and say that all the books on this shelf are French. But there is no inference involved.

Complete enumeration which admits of no inductive inference is practical only when the group considered is comparatively small. For such general statements as "Every month in the year has less than thirty-two days," complete enumeration may be used. But should we wish a general statement about larger classes such as roses, fishes, people, complete enumeration is impossible. In such cases inductive inference must be used, either *induction by enumeration*, or *induction by essential characteristics*. Induction by enumeration cannot furnish final proof for its conclusions, since these are based on the law of probability; the point of complete certainty can never be reached. Conclusions from induction by enumera-

tion, like conclusions from reasoning by analogy, are valuable as working hypotheses to be tested by reference to facts, and that is about all.

Induction by Essential Characteristics.—Everything possesses characteristics that are accidental to it and those that are essential. For instance, the color of a book is an accidental characteristic; that the leaves are bound together is an essential characteristic. The peculiar shape of a person's head is an accidental characteristic; it varies with every individual; the possession of a heart is a characteristic essential to a human being. When an essential characteristic is known, one inherent in the very nature of the thing being considered, we may be sure that it is possessed by every member of that class of things.

If we should analyze one A and find that its characteristics are l, m, n, r, etc., and upon more careful study become convinced that of these, r is essential to the existence of an A, we may safely infer from this analysis the general principle, "Every A possesses r." This is *Induction by Essential Characteristics*, sometimes called *Induction by Analysis*. We might have analyzed more than one A, as A1, A2, A3, A4, before making any general inference as to all A's. Perhaps there would have been less danger of our being mistaken as to the essentialness of r had we done so. However, had one or many individual instances been examined, if r is in fact essential to A, the general conclusion would be valid.

The general statement, "All trees have roots," may result from an examination of one or more trees,

which determines the possession of roots to be an inherent characteristic, without which a tree could not exist. That a grain of corn should, when planted, first appear as a single shoot; that a bean should show two first leaves, and a white pine should show six, may be discovered by an examination of one seed of each. Such an examination will reveal a structure which makes these habits or laws of germination absolutely necessary.

EXERCISE 27

How has induction been employed in arriving at the following conclusions, and which kind of induction was employed?

1. Atmospheric density varies inversely with altitude.
2. The guilty mind needs no accuser.
3. As the boy, so the man.
4. Mercury may be transmuted into gold by electric action.
5. Illumination varies inversely as the square of the distance.
6. The principle of the storage of electricity.
7. The explosiveness of dust.
8. Mendel's law of variation.
9. The principle of inductive inference.
10. Specific gravities of the various elements.

CHAPTER XI

MEDIATE INFERENCE—DEDUCTION

The next method of thinking to be explained is the way we have of arriving at a new judgment by combining two given judgments. This method is called *deduction*; the two judgments are the *premises*; and the resulting judgment is the *conclusion*. The two premises, known as *major premise* and *minor premise*, must be such that the *conclusion* inevitably flows from them when they are combined.

Of the two premises one must be a universal proposition; the other may be either a partial proposition or a less general universal one.

The *conclusion* may be either a partial or a universal proposition, but in either case, its range of application cannot be greater than that of either of its premises.

Whenever the two premises are true and certain laws, yet to be explained, are observed, the conclusion cannot fail to be true, and the reasoning is said to be "valid."

Thus it might be accepted that "all planets revolve about the sun." Then let it be found that a newly discovered body is a planet; it follows that it, too, revolves about the sun. It is not necessary to wait to see whether the newly discovered body will

complete its orbit. The reasoning here runs in this way:

All planets revolve about the sun. (*Known law.*)

This body is a planet. (*Discovered fact.*)

Therefore, this body revolves about the sun.
(*Inferred conclusion.*)

The typical case of deductive reasoning is called a *Syllogism*, and takes this form:

All X's are B's.

All A's are X's.

Therefore, All A's are B's.

In this example it will be noticed the propositions are stated in terms of denotation. They can be stated in terms of connotation as well. Then the above would be:

The essential qualities (*connotation*) of X are included in the essential qualities of A.

The essential qualities of B are included in the essential qualities of X.

Therefore, the essential qualities of B are included in the essential qualities of A.

Each of the propositions employed in a case of deductive reasoning—the two premises of the syllogism—may have come from any one of several sources. It may have been derived from personal experience or accepted upon the testimony of another person; it may have been handed down by tradition or picked up out of current opinion; it may be a conclusion

from a previous logical process, either inductive or deductive. However it may have been acquired is not important. If the premises of the syllogism are both true, the resulting conclusion must be true, unless some error is committed in the reasoning process. It is a function of deductive logic to show what errors are possible in this kind of thinking, how they are committed, and how avoided.

Comparison of Induction and Deduction.—Deduction, in contrast with induction, is used primarily as means of demonstrating and instructing. Fundamentally, these two ends may be regarded as identical, or at least very nearly related. The teacher who knows numerous facts in his field may know them individually or he may know them by means of general formulas. Then he has the duty of passing them on to his student. Too often, possibly, he merely announces his knowledge and relies upon his authority to secure acceptance. When he undertakes really to convince the student of its correctness he resorts to proof or demonstration. In this task he almost certainly employs the deductive method.

We are all teachers in the sense that we endeavor upon occasion to convince others of what we hold to be the truth. We then turn to deduction as our chief means of persuasion.

In contrast with deduction, induction is the method of research or discovery. When we wish to find out anything we look for facts; observation is then called upon. If the facts we wish are thus secured, we use them to meet our practical needs.

Usually we are not satisfied with the mere facts thus obtained and we go on to the establishment of an empirical law. An empirical law is a most convenient and most comprehensive form for our knowledge of facts, and we press forward to it whenever we can.

It is a great mistake, however, to think that induction and deduction are two distinct methods of thinking which are in any way conflicting or competing. Unfortunately there is a tradition to that effect. Lord Bacon believed he had discovered a new method, which he outlined in his famous *Novum Organum*, and that it was opposed to the method described in Aristotle's *Organon*. It is true that in the *Organon* Aristotle emphasized the deductive method, and in the *Novum Organum* Bacon emphasized the inductive method. But the careful student sees that in both cases it is only a matter of emphasis. The truth is that neither induction nor deduction can function alone. They are as mutually dependent on each other as are connotation and denotation, or as the two legs of a man are when used as means of locomotion. In all practical thinking, except in the simplest and briefest cases, there is a prolonged series of judgments at one time inductively employed, at another, deductively. During the inductive moments general propositions are built up. These are then used to derive other facts by taking deductive steps. Thus the argument proceeds, each method contributing what it alone can contribute. In the realm of practical thinking, this was as true before Bacon as it has been since. He was offended by the prevailing

occupation of the scholars of his day who were mostly devoted to teaching by basing their arguments upon dogmas accepted upon ecclesiastical authority, not upon facts found in human experience.

And even while Aristotle was writing his great work on thinking, the first known work on logic, people employed induction in their thinking just as they do today. Aristotle was most interested in convincing people of his doctrines and consequently was most given to delineating the mental processes, adapted to that end. Naturally he made the most of deduction.

Now we see that both Aristotle and Bacon were right in what they asserted, but that neither asserted the whole truth regarding thought processes. For valid thinking of any consequence, induction and deduction are essentially supplementary, not opposing processes.

Uses of Deduction.—Deduction is useful in three separate and distinct ways:

I. It enables us to bring together two facts, previously known to us but not yet related in our experience, and find out from them another fact.

Napoleon was the French commander at Waterloo.

This man caught trudging in the dark through the mud toward Paris is found to be Napoleon.

Therefore, this miserable looking little man was the French commander in the morning.

This is an example of two facts put together to yield a third.

A little later it was added that the man who commanded the French army must be made permanently powerless.

Therefore, this man must be made permanently powerless.

To exile him for life to St. Helena will make him permanently powerless.

Therefore, he must be exiled for life to St. Helena.

By some such reasoning was the fate of Napoleon determined. Individual facts make up the substance of the reasoning.

II. A second use of the deductive method of reasoning is the application of known *general laws to particular instances*.

All known species of lizards are oviparous.

The extinct saurians were lizards.

Therefore, the extinct saurians were oviparous.

This syllogism was accepted as perfectly valid long before the discovery of petrified saurian eggs in Thibet in 1924. The empirical law that lizards lay eggs was derived by Induction. Millions of observations, casual and systematic, extending through centuries provided the data from which the law was derived. That the saurians, although extinct, were lizards similar to those still living, was certain, since their remains showed that they had the

same essential characteristics. Only by linking the two propositions together was it concluded deductively that the extinct saurians were oviparous. After the fossil eggs had been discovered, no doubt remained that the saurians were oviparous. This is a fair example of how we are continually weaving together our knowledge and explaining it as the years pass. In this way the people who observe and the people who think are both adding to our wealth of known truth.

Such a bringing together of two presumably truthful judgments, previously separated, and their logical combination into a third true judgment, is one of the commonest of experiences for intelligent beings. Both of the premises may have been lying unrelated and dormant in the mind for some time. Or, what is more probable, one of them, the general proposition, may have been stored away, while the second is a newly acquired fact of personal experience. What is called "good judgment," so highly praised, is largely just this ability to bring together a fact, freshly discovered, and a general judgment suitable for the purpose but long since deposited in the archives of the memory.

That the memory plays a considerable part in deductive thinking is evident from what has been said. Memory preserves our knowledge in the form of general propositions and makes it available for us, on occasion. Memory also carries along the rules which we must observe in our thinking if we wish to avoid going astray.

When two judgments are brought face to face in

consciousness, their logical combination into a conclusion is largely a matter of following established rules. This last step of deductive reasoning seems to be quite mechanical, so much so that it has been suggested that it might be performed by a machine, similar to the recently invented computing machines in common use in business houses. However, the dream of the logic machine to do our thinking for us must probably remain a dream for some time yet, and the human intellect will have to be relied upon to perform this necessary task.

III. A third use of Deduction is as a means of *testing alleged empirical laws*. General propositions are being scattered about by conversation, by the press, by teachers, by books. Some of them are always true; some are usually true, but not always; some are true, but rarely so; and some are false and only false. We cannot decide by their form or origin whether they are to be trusted or not. We must have some method of testing them before placing great reliance upon them. We have this method in deductive reasoning. We can try out the proposed empirical law by applying it to an individual instance embraced under it, and in this way we may find out whether it is safe to accept it. If the conclusion resulting is shown by observed facts to be true, then we feel that the general proposition is true. Leastwise it is not shown to be false. Of course, a single test of this kind must not be accepted as final. It only adds to the presumption that the proposition is true. This method of testing a proposition is called *Verification*.

A principle of economics that was long accepted by the popular mind asserts that the lowest prices are guaranteed by a free operation of competition and the law of supply and demand. When tried in certain industries, however, such as the manufacture of steel and gasoline, the principle does not seem to be necessarily valid. Large-scale production makes possible low prices, and large-scale production may sometimes be possible where monopoly prevails. Therefore, the empirical law of the dependence of low prices on the free working of competition and the law of supply and demand fails to stand the test and must be abandoned or qualified in such a way as to avoid the test which overthrew it.

FORMS OF DEDUCTION

Enthymemes.—If at the close of an election count we ask, “Was Mr. J. elected?” and we are told, “The whole Republican ticket was elected, and Mr. J. is a Republican,” although it has not been specifically answered, we have been given ample information to answer our question for ourselves. Had our informant drawn the conclusion, “Therefore Mr. J. was elected,” the remark would have seemed quite superfluous.

If we ask the question, “Is the accused guilty of the crime?” and we are given the reply, “He is a member of the gang; of course he is guilty,” we would readily infer that if membership in the gang is considered sufficient grounds for asserting guilt, it must be that all members of the gang are guilty. Had the reply been, “All members of the gang have been

proven guilty; of course he is guilty," the case would be equally intelligible. From this we would draw the inference that he was a member of the gang. Had we been given the reply, "All the gang were guilty and he was a member of the gang," the conclusion that he was guilty would have been too obvious to need stating. The entire deductive process involved in answering the question, "Was he guilty?" is:

All of the gang have been proven guilty.

He is a member of the gang.

Therefore, he is guilty.

When all three steps are thus stated it is a syllogism.

Each argument given above has omitted one of the three propositions involved. When deductive reasoning is thus abbreviated by the omission of one of its three steps, it is known as an *Enthymeme*. Since any one of the three parts may be omitted, it gives rise to three kinds of enthymemes.

In an enthymeme of the *first order* the general statement upon which the conclusion is based—the major premise—is omitted.

In an enthymeme of the *second order*—the minor premise—the specific instance coming under the general statement and connecting it with the conclusion, is omitted.

In an enthymeme of the *third order* the conclusion itself is omitted.

Probably the most common use made of deductive reasoning is by means of the enthymeme. It has the advantage over the syllogism (deductive reasoning

completely expressed) in the point of brevity. Also it is much more interesting because it leaves something for the listener or the reader to supply, and it does not bore him by expressing the obvious. In our everyday thinking we use many times more enthymemes than we do syllogisms.

The danger in the use of the enthymeme arises from taking for granted judgments unexpressed. In enthymemes of the first order we are liable to be but vaguely aware of the general principle we are using in drawing our conclusions; very frequently if we were clearly aware of it we would reject the conclusion drawn. In an enthymeme of the second order we may be mistaken in our tacit assumption that the specific instance involved comes under the general law given. And to leave a conclusion for someone else to draw, as is done in the enthymeme of the third order, is always risky. Any of these may be tested, however, by supplying the missing proposition.

The following are examples of enthymemes:

First order:

(Major premise omitted.)

Mr. X is a senator.

Therefore, he is a citizen of the United States.

Second order:

All senators must be citizens of the United States.

(Minor premise omitted.)

Therefore, Mr. X is a citizen of the United States.

Third order:

All senators must be citizens of the United States.

Mr. X is a senator.

(*Conclusion omitted.*)

EXERCISE 28

Indicate the order of the following enthymemes and supply the missing proposition.

1. Copper is a metal.
Therefore, it conducts electricity.
2. All German philosophers are obscure.
Schopenhauer was a German philosopher.
3. Every man has his price.
Therefore, Judas betrayed his Master.
4. No man can serve two masters.
Therefore, you cannot.
5. This is a good investment.
Therefore, you should invest in it.
6. Good soldiers obey orders.
He is not a good soldier.
7. If Yale does not win this game, it loses the championship.
Yale wins the championship.
8. "Who did sin, this man or his parents, that he was born blind?"
9. Since Russia has a communistic form of government,
it should not be recognized by other nations.
10. Lightning will not strike here because it never strikes twice in the same spot.

Syllogisms.—Enthymemes were described as deductive reasoning when one proposition is omitted.

A syllogism is an instance of deductive reasoning in which all three propositions are explicitly stated.

Syllogisms owe much of their value as methods of thinking to two characteristics. The first is that their complete statement of reasoning makes apparent any errors that would otherwise be obscure and might escape unnoticed; and second, there are definite rules to which they may be subjected, conformity to which assures the accuracy of their conclusions. Of course it is essential in syllogisms that the data, the premises, be correct, but starting with truthful premises and correctly applying the recognized rules for valid syllogisms, the conclusions resulting may be trusted.

There are three types of syllogisms, involving different principles, each type being governed by its own set of rules. They are:

I. The *alternative syllogism*.

A is either X or Y (but not both).

A is X.

Therefore, A is not Y.

II. The *hypothetical syllogism*.

If A is X, B is Y.

A is X.

Therefore, B is Y.

III. The *categorical syllogism*.

All X's are B's.

All A's are X's.

Therefore, All A's are B's.

Alternative Syllogism.—The process of elimination, so often a factor in our thinking, begins with an alternative proposition. For example: There is a vacancy on the first team. This vacancy will be filled by either Smith, Jones, or Brown. It is learned that both Smith and Jones fail to make the place. Therefore, Brown will be chosen to fill the vacancy. Either Loeb or Leopold struck the fatal blow. Loeb struck the fatal blow. Therefore, Leopold did not. *Alternative syllogism* is the name given to such reasoning since the major premise is an alternative proposition.

The danger signal that needs to be placed here as a warning is that only when the alternatives in the major premise are mutually exclusive may the process of elimination be applied and a true conclusion result. To reason that "Either Loeb or Leopold was guilty of murder; Loeb was guilty; therefore, Leopold was not guilty," illustrates the error to which the lack of mutual exclusiveness will lead, for both were guilty.

The following are examples of different types of alternative syllogisms:

1. Either A or B is X (but not both).
A is X.
Therefore, B is not X.

Either helium or hydrogen is an inflammable gas.

Helium is not an inflammable gas.

Therefore, hydrogen is an inflammable gas.

2. A is either X or Y.
A is not Y.
Therefore, A is X.

Some five hundred years ago the process of elimination was being applied to the proposition, "The world is either spherical or flat," with the resulting conclusion that the world is not flat because it is spherical.

3. Either A is X or B is Y (but not both).
A is X.
Therefore, B is not Y.

Either the engine needs repairing or the gas tank is empty.

The gas tank is not empty.

Therefore, the engine needs repairing.

These illustrations show the types of syllogisms that result from the use of the alternative proposition as major premise. Many variations in these are possible, since the minor premise may be affirmative or negative.

EXERCISE 29

I. Using the following as major premises, complete the syllogisms:

1. Animals are either vertebrate or invertebrate.
2. Water is either gaseous, liquid, or solid.
3. This proposition is true or it is not true.

4. The moon is either made of green cheese or it is not made of green cheese.
5. Either Fascism will succeed or Mussolini will go down.

II. How many alternative syllogisms may be made from each of the following?

1. Either A, B, or C is X.
 2. Either A is X or B is Y.
-

Hypothetical Syllogism.—When we have a truthful statement of hypothetical knowledge, represented by “If A is X, B is Y,” and further information assures us that A is X, by thinking a little further we know that B is Y. That follows necessarily from the affirmation of the antecedent of our hypothetical proposition. “Whenever the demand for a product exceeds the supply, the price of that product will rise. The demand for steel now exceeds the supply. Therefore, steel will advance in price.” This is a valid hypothetical syllogism.

Beginning with the information, “If A is X, B is Y,” if we have further information which assures us that B is not Y, it will follow without need of more investigation that A is not X. Denying the consequent in this way inevitably denies the antecedent. “When no candidate for the Presidency receives a majority of the electoral votes cast, the duty of the election falls upon the House of Representatives. In the last election that duty did not fall upon the House of Representatives. Therefore, some candidate re-

ceived a majority of the electoral votes cast." This, also is a valid hypothetical syllogism.

The process of thus resolving a hypothetical proposition into a categorical is called a *hypothetical syllogism*. A hypothetical syllogism consists of one hypothetical proposition and two categoricals. The hypothetical proposition is the major premise; the minor premise and conclusion are categorical propositions.

Much of our information comes to us in the form of hypothetical propositions, whether that information be concerned with personal, everyday matters or with the wider realms of interest, embracing universal laws and principles. "If the fliers reach New York safely, they will have encircled the globe." "Whenever sun spots are numerous, there are electrical storms on the earth." "If the cause of cancer can be discovered, that disease can be controlled." These are samples of this kind of information.

But we are not satisfied to leave our knowledge in this form. We may be much more interested in knowing whether or not the fliers encircled the globe and whether there is to be an electrical storm tomorrow than we are in knowing the conditions on which these possible facts may occur. To resolve the hypothetical major premise into a categorical proposition and thus get this definite, desired information is a task that frequently confronts us.

The possibility in the minor premise of either affirming or denying the antecedent or the consequent of the major premise, gives rise to four forms of the hypothetical syllogism. Of these only two give valid conclusions. These four forms are:

- (1) If A is X, B is Y.

A is X.

Therefore, B is Y.

If Russia mobilizes, there will be war.

Russia mobilizes.

Therefore, war is certain. (*Valid*)

- (2) If A is X, B is Y.

A is not X.

?

If this strategy is adopted, the battle will be won.

This strategy is not adopted.

Therefore, the battle will be lost. (*Invalid*)

- (3) If A is X, B is Y.

B is Y.

?

If oil is found under this land, it will become valuable.

The land becomes valuable.

Therefore, oil was found under it. (*Invalid*)

- (4) If A is X, B is Y.

B is not Y.

Therefore, A is not X.

If Smith is elected, taxes will be reduced.

Taxes were not reduced.

Therefore, Smith was not elected. (*Valid*)

The only known relation between A and X and B and Y in the major premises of the syllogisms given is

that B is Y whenever A is X. There is nothing to indicate what the relation between B and Y would be should A not be X. Likewise, if B should be found to be Y, there is nothing to indicate what the relation would be between A and X. To illustrate further, we will take as a major premise, "If the switch is left open, there will be a wreck." To know that the switch was closed (*the denial of the antecedent*) may lessen the probability but it gives no proof that there will be no wreck (*the denial of the consequent*), for a wreck might result from other causes. Or if we should learn that there was a wreck (*affirming the consequent*), our major premise gives us no grounds for assurance that the switch had not been closed (*affirming the antecedent*). It does not assert that only in the case of the switch being left open can there be a wreck. It merely asserts that if the switch is left open there will be one. It makes no pretence of denying the possibility of other factors causing a wreck. Therefore to affirm the consequent or to deny the antecedent gives no conclusion.

The rules for the formation of valid hypothetical syllogisms are:

1. To affirm the antecedent is to affirm the consequent.
2. To deny the consequent is to deny the antecedent.

EXERCISE 30

I. With the following as major premises, formulate complete syllogisms:

1. If the Eighteenth Amendment cannot be enforced, it should be repealed.
2. Asiatic history will be taught in our schools when there is sufficient demand for it.
3. If France cannot pay the amount borrowed, concessions must be granted her.
4. When west meets east, their cultures will fuse.
5. Should secret diplomacy be abolished, international confidence will be increased.

II. Supply hypothetical major premises for the following:

1. Prices are falling.
Therefore, money is plentiful.
2. A rally was not held last night.
Therefore, there is no game today.
3. Our party does not have a large campaign fund.
Therefore, it will not win the election.
4. The barometer is falling rapidly.
Therefore, a storm is certain.
5. The seismograph shows unusual vibrations.
Therefore, an earthquake has occurred.
6. Manufacturers of breakfast foods failed to form a combination.
Therefore, prices of their products were not advanced.
7. This young man has to work his way through college.
Therefore, he will be a successful student.

CHAPTER XII

DEDUCTION

FORMS OF DEDUCTION (*Continued*)

Dilemmas.—Life is constantly confronting us with series of choices—choices upon which, whether we wish it or not, we must decide; for even to seem to make no choice at all is itself to choose not to decide.

Shall I finish my college course or enter a law school?

Shall I curtail my expenses so I can live within my allowance or shall I go into debt?

Shall I prepare for a commercial or a professional career, or shall I go to work immediately without any special preparation?

Shall I wear my raincoat and rubbers or risk getting wet without them?

Shall I specialize in English, science, or one of the foreign languages?

Our choice from among such alternatives may be a random one based on some whim or chance suggestion; or we may let "fate" decide it for us. On the other hand, our choice may be founded on an intelligent consideration of the probable consequences of each alternative and the weighing of their relative worth.

The term "dilemma" is popularly used to designate almost any sort of predicament such as these, in which one may find oneself. In logic, *dilemma* is used to designate a method for getting out of such a predicament. It gives what might be termed a mechanism for the sifting of facts and the marshalling of them in a thoughtful solution of the problem.

The framework of the logical dilemma consists of a compound hypothetical proposition as a major premise, an alternative proposition as a minor premise, and either a categorical or an alternative proposition as a conclusion. This framework is filled in by finding the antecedents or the consequents that result from the complicated problem confronted. This gives the compound hypothetical proposition of the major premise. In the minor premise the two antecedents of the major premise must be affirmed disjunctively or the two consequents must be denied disjunctively.

Before adopting the minor premise, one must make sure that the alternatives given are exhaustive, that is, that no others may be substituted for them, and that they are mutually exclusive.

From such an arrangement of the material presented by the situation under consideration a reliable conclusion may be drawn.

For example:

If I remain in school, I must curtail my expenses, and if I remain in school, I must also borrow money.

I find that either I cannot curtail my expenses or that I cannot borrow sufficient funds.

Therefore, I cannot remain in school.

A striking instance of the effectiveness of the dilemma was the humiliation of Douglas by Lincoln in their famous debate. Lincoln planned to ask a certain question of his opponent, which his friends advised against. Lincoln replied that if Douglas answered the question affirmatively, it would elect him to the Senate, for which they were both candidates, but that it would ruin him as a future candidate for the presidency. On the other hand, if Douglas replied negatively, Lincoln would beat him in the race for the Senate. Subsequent events proved that Lincoln was right. Douglas answered affirmatively and became senator, but Lincoln became president four years later.

Types of Dilemmas.—A dilemma is said to be *simple* when its conclusion is a categorical proposition; *complex* when its conclusion is an alternative proposition. It is called *constructive* when its conclusion is affirmative, *destructive* when its conclusion is negative. There are, therefore, four kinds of dilemmas: Simple Constructive, Simple Destructive, Complex Constructive, and Complex Destructive.

When the two hypothetical propositions which make the major premise of a dilemma have the same consequent, it is a *simple constructive dilemma*. In the minor premise the two antecedents are dis-

junctively affirmed. The conclusion affirms the consequent.

Examples:

If A is X, B is Y, and if C is Z, B is Y.

Either A is X or C is Z.

Therefore, B is Y.

If M buys oil stock he will probably lose his money, and if he buys wheat futures he will probably lose his money.

M has determined to invest his money either in oil stock or December wheat.

Therefore, he will probably lose it.

When the two hypothetical propositions that compose the major premise of a dilemma have the same antecedent, it is a *simple destructive dilemma*. The consequents of these hypothetical propositions are disjunctively denied in the minor premise. The conclusion denies the antecedent.

Examples:

If A is X, B is Y, and if A is X, C is W.

Either B is not Y or C is not W.

Therefore, A is not X.

If I win this case, I must impeach the testimony of one of the witnesses, and if I win the case, I must induce the judge to give certain instructions to the jury.

Either I cannot impeach the testimony of the

witness or I cannot induce the judge to give the needed instructions to the jury.

Therefore, I shall lose the case.

The *complex constructive dilemma* is like the simple constructive except that the hypothetical propositions used as its major premise have different consequents. When the two antecedents are disjunctively affirmed in the minor premise, the conclusion must be a disjunctive affirmation of the consequents.

Examples:

If A is X, B is Y, and if C is Z, D is W.

Either A is X or C is Z.

Therefore, B is Y or D is W.

If the exploring party succeeds in their attempt to climb Mt. Everest, they will win fame; and if they fail they will have had an exciting adventure.

Either they will succeed or they will fail.

Therefore, they will be famous, or they will have had an exciting adventure.

If I plead guilty, I lose the chance of being acquitted, but have the hope for leniency from the court; if I plead not guilty I take the chance of conviction with no hope of leniency from the court.

I must either plead guilty or not guilty.

Therefore, I must either lose the chance of being acquitted and may hope for leniency from the court or I must take the chance of conviction without hope of leniency.

The *complex destructive dilemma* has both antecedents and consequents that are different in the two hypothetical propositions which make up its major premise. The two consequents are disjunctively denied in the minor premise. In the conclusion the two antecedents are disjunctively denied.

Examples:

If A is X, B is Y, and if C is Z, D is W.

Either B is not Y, or D is not W.

Therefore, either A is not X or C is not Z.

A beleaguered garrison were convinced that if they used their artillery they would endanger their supply of ammunition, and that if they made a sortie they would probably lose men valuable for the continued defense of their position. They might endure one of these losses, but not both. Either they must not deplete their supply of ammunition or they must not reduce their man power. From this they properly concluded that they must either not make much use of their artillery or they must not make a sortie. This was a valid complex destructive dilemma.

EXERCISE 31

I. Using the following as major premises, supply minor premises and conclusions and tell what type of dilemma results:

1. If A is X, B is Y; and if C is Z, B is Y.
2. If A is X, B is Y; and if A is X, D is W.
3. If A is X, B is Y; and if C is Z, D is W. (Two dilemmas in this case.)
4. If A is not X, B is Y, and if M is N, B is not Y.
5. If A is X, B is not Y, and if T is not S, R is W.
6. If B is Y, C is not Z, and D is not W.

II. Substitute concrete ideas in place of the letters in the first three of the foregoing and complete the dilemmas.

Categorical Syllogism.—In a categorical syllogism all three of the propositions must be categorical and together they must *contain but three terms*. Each term appears twice in the syllogism. The one appearing in each of the premises and not in the conclusion is called the *middle term*. It is the middle term that is the measure or intermediary which makes known a relation between the other two terms and thus makes possible a conclusion. In the categorical syllogism given below, “X” is the middle term:

All X's are B's.

All A's are X's.

Therefore, all A's are B's.

In the following

Chinese are Mongolians.

Confucius was a Chinese.

Therefore Confucius was a Mongolian.

“Chinese” is the middle term. Had the premises been

All Chinese are Mongolians.

Confucius was a wise man,

no middle term, that is, a term common to both premises, would have been used and from them no conclusion would be possible.

Major term and minor term are the names given to the other two terms of the syllogism. The only way of determining which term is major and which term is minor is by the use made of them in the conclusion. The term used as subject in the conclusion is the *minor term*. The one used as predicate of the conclusion is the *major term*. As a general rule, the denotation of the predicate of a categorical proposition is larger than that of the subject, which accounts for the predicate being called the major term and the subject the minor term.

Some means of distinguishing one premise from the other is needed and this is done by calling the premise which contains the major term the *major premise*, and the one containing the minor term the *minor premise*. Each premise thus receives its designation from the major or minor term it contains.

In actual use premises and conclusion may appear in any order within a syllogism. For example:

This stone is combustible; (*conclusion*)
because this stone is a diamond, (*minor premise*)
and all diamonds are combustible. (*Major pre-*
mise)

This is the same as:

All diamonds are combustible. (*Major premise*)

This stone is a diamond. (*Minor premise*)

Therefore, this stone is combustible. (*Conclusion*)

The order last used, major premise, minor premise, conclusion, is the normal order for the formal stating of syllogisms.

EXERCISE 32

I. In each of the following categorical syllogisms what are: (a) The middle, major, and minor terms? (b) The major premise? (c) The minor premise?

1. No A's are X's.

All B's are X's.

Therefore, no B's are A's.

2. All M's are N's.

Some M's are S's.

Therefore, some S's are N's.

3. All M's are N's.

No N's are T's.

Therefore, no M's are T's.

4. All X's are B's.

All A's are X's.

Therefore, all A's are B's.

5. All islands are bodies of land surrounded by water.

This is an island.

Therefore, this is a body of land surrounded by water.

6. No bill of attainder may be passed by congress.
This law was passed by congress.
Therefore, this law is not a bill of attainder.
7. These bonds are a safe investment, because they are United States government bonds, and all United States government bonds are a safe investment.
8. Since no A is an X and all X's are Z's, some Z's are not A's.
9. Every B is an M; consequently some M's are S's, because every S is a B.

II. Syllogisms in Exercise 33 (page 194) may be used here for further practise.

Moods of Categorical Syllogisms.—When we remember that there are four kinds of categorical propositions, *A*, *E*, *I*, *O*, and that a syllogism is a combination of any three of these, as *A*, *E*, *O* (major premise *A*, minor premise *E*, conclusion *O*), it is obvious that a good many different formal categorical syllogisms may be made by combining them into all the possible groups of three. By actual count there are sixty-four. These are known as the moods of the syllogism. If all these moods gave valid syllogisms, there would be no task of deciding when deductive reasoning may be relied upon. However, the majority of them are invalid.

Validity depends mainly upon the *distribution* of the terms used and upon the inclusion or exclusion

of the denotation of one term by the denotation of the other. In the following syllogisms the distribution and the inclusion may be shown by the use of the Euler diagrams.

All X's are B's.
 All A's are X's.
 Therefore, all A's are B's.

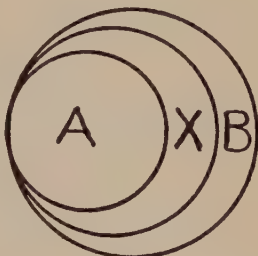


FIG. 12

No X's are B's.
 All A's are X's.
 Therefore, no
 A's are B's.

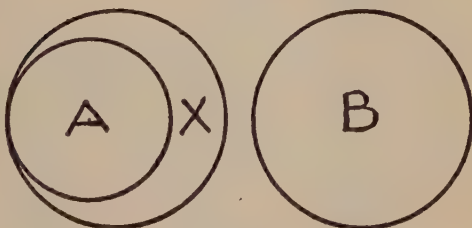


FIG. 13

All A's are X's.
 All B's are X's.
 Therefore, all B's are A's.

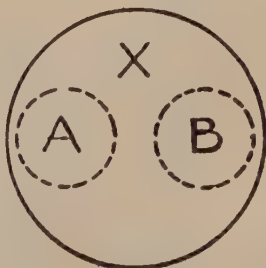


FIG. 14

These syllogisms, the first two, *AAA* and *EAE*, valid, and the third, *AAA*, invalid, indicate the dependence of the validity of syllogisms upon the distribution of terms and the inclusion or exclusion of one term by another. With this as the basis, the following eight rules have been worked out, governing the validity of syllogisms:

1. When a conclusion is universal both premises must be universal.

(Rules involving distribution of terms)

2. The middle term must be distributed in at least one premise. Violation of this rule is called *undistributed middle*.

3. No term may be distributed in a conclusion that is not distributed in its premise. Violation of this rule by the major term is called *illicit process of the major term*; if by the minor term it is *illicit process of the minor term*.

(Rules involving negative propositions)

4. No conclusion may be drawn from two negative premises.

5. When one premise is negative the conclusion must be negative.

6. When the conclusion is negative one premise must be negative.

(Rules involving partial propositions)

7. When one premise is partial, the conclusion must be partial.

8. When both premises are partial no conclusion is possible.

In the following list of the sixty-four possible moods of categorical syllogisms the number of the rule most obviously violated is placed after each invalid mood. Some moods violate more than one rule; for instance, IIE violates rules 1, 2, 3, 6, 7, and 8. After eliminating the invalid moods only *eleven* are left as valid. The first letter indicates the type of categorical proposition used in the major premise, the second letter indicates the type used in the minor premise, and the third the type used in the conclusion.

<u>AAA</u>		<u>EAA</u> 5	<u>IAA</u> 1	<u>OAA</u> 1,5
<u>AAE</u> 6		<u>EAE</u>	<u>IAE</u> 1,6	<u>OAE</u> 1
<u>AAI</u>		<u>EAI</u> 5	<u>IAI</u>	<u>OAI</u> 5
<u>AAO</u> 6		<u>EAO</u>	<u>IAO</u> 6	<u>OAo</u>
<u>AEA</u> 5		<u>EEA</u> 4	<u>IEA</u> 1, 5	<u>OEA</u> 1,4
<u>AEE</u>		<u>EEE</u> 4	<u>IEE</u> 1, 7	<u>OEE</u> 1,4
<u>AEI</u> 5		<u>EEI</u> 4	<u>IEI</u> 5	<u>OEI</u> 4
<u>AEO</u>		<u>EEO</u> 4	<u>IEO</u> 3	<u>OEO</u> 4
<u>AIA</u> 1		<u>EIA</u> 1, 5	<u>IIA</u> 1,8	<u>OIA</u> 1,5,8
<u>AIE</u> 1,6		<u>EIE</u> 1	<u>IIE</u> 1,6,8	<u>OIE</u> 1,8
<u>AII</u>		<u>EII</u> 5	<u>III</u> 8	<u>OII</u> 5,8
<u>AIO</u> 6		<u>EIO</u>	<u>IIO</u> 6,8	<u>OIO</u> 8
<u>AOA</u> 1,5		<u>EOA</u> 1,4	<u>IOA</u> 1,5,8	<u>OOA</u> 1,4,8
<u>AOE</u> 1		<u>EOE</u> 1,4	<u>IOE</u> 1,8	<u>OOE</u> 1,4,8
<u>AOI</u> 5		<u>EOI</u> 4	<u>IOI</u> 5, 8	<u>OOI</u> 4,8
<u>AOO</u>		<u>EOO</u> 4	<u>IOO</u> 8	<u>OOO</u> 4, 8

The eleven moods underlined above are the only moods with valid conclusions. And their validity depends upon the "Figure" in which they occur.

Figures of the Categorical Syllogism.—There are four figures in the categorical syllogisms resulting from the four possible positions of the *middle* term in the premises. In none of these figures are all of the eleven possible moods valid. Remembering that the major premise is placed first, the minor premise second, and the conclusion third, and symbolizing the *middle* term by Mid., the *major* term by Maj., and the *minor* term by Min., the four figures are as follows:

First Figure

Mid. is Maj.
Min. is Mid.
Therefore, Min. is Maj.

Second Figure

Maj. is Mid.
Min. is Mid.
Therefore, Min. is Maj.

Third Figure

Mid. is Maj.
Mid. is Min.
Therefore, Min. is Maj.

Fourth Figure

Maj. is Mid.
Mid. is Min.
Therefore, Min. is Maj.

To find out what syllogisms are valid in any given figure requires the application of the rules of validity to each of the eleven moods when put into that figure.

EXERCISE 33

I. Which of the following syllogisms are valid? If invalid, indicate the fallacy.

1. All A's are X's.
No B's are X's
Therefore, no B's are A's.
2. All X's are A's.
All B's are X's.
Therefore, all B's are A's.
3. All A's are X's.
All B's are X's.
Therefore, all B's are A's.
4. No X's are A's.
All X's are B's.
Therefore, no B's are A's.
5. No A's are X's.
All B's are X's.
Therefore, no B's are A's.
6. All X's are A's.
No B's are X's.
Therefore, no B's are A's.
7. All A's are X's.
All X's are B's.
Therefore some B's are A's.
8. Some A's are not X's.
All A's are B's.
Therefore, some B's are not X's.
9. No A's are X's.
All X's are B's.
Therefore, no B's are A's.

10. Some A's are X's.
Some B's are A's.
Therefore, all B's are not X's.

II. Throw the following arguments into syllogistic form and indicate which are valid and which are invalid and why. Note that the enthymeme is used, that more than one syllogism may be involved, and that immediate inference is sometimes employed.

1. I am a man and all men are mortal. Therefore, I must no longer postpone buying a life insurance policy and making my will.

2. America ought to cancel the French debt because she has so much more wealth than France and such a settlement would insure perpetual good feeling between the two countries.

3. My observation leads me to the opinion that the lawyer spends more of his time sitting down than any other man. So I have decided to take a course in the law school.

4. "Public office is a public trust." The man who is trusted has an advantage over the man who is not. This is my secret reason for becoming a candidate for office.

5. All the best governments are democratic in form. Latin-American governments are essentially oligarchic. For these reasons they can never function effectively and the Monroe Doctrine must be enforced.

6. I am only one of sixty million legal voters and therefore do not count. Why should I discommode myself by going to the polls?

7. The name of the Deity does not appear in the Constitution of the United States, and for that reason some citizens will not exercise their right of suffrage.

8. Many men who use tobacco suffer from characteristic heart disorders. That is reason enough why young women should not smoke cigarettes.

9. The industrial classes are exceedingly prosperous, while the farmers are falling behind economically every year. It is clear that the government should do something for agriculture.

10. Large aggregations of capital are the result of the labor of many poor men and the operation of certain statutes. Therefore, those statutes should be repealed that the workers may live happier lives and the idle rich be saved from demoralization.

11. Military training should be required of all college students for we are sure to have a war some time and every man should be prepared to do his duty.

12. England was wise and stabilized her currency immediately after the war. She will certainly profit by her policy in the long run, embarrassing as it was at the time.

14. I am entering this class because it is notoriously easy and a hard course would interfere with other things I wish to do.

15. I must complete my college course at whatever cost because I am told that the more exalted the position in life, the more university men there are who have attained to it.

16. Essentially we are all most concerned about our own personal welfare. Eternity is a long time and much

can happen in it. I must therefore be careful to adhere to the religious convictions of my youth.

17. That senatorial candidate spent a million in winning his nomination and for that reason Senator B. announces that he will vote against his admission even if he is elected.

18. Mexico has prohibited the teaching of her children by representatives of ecclesiastical societies. She will certainly deteriorate morally and will be an increasing source of embarrassment to her neighbors.

19. Books are the means of transmitting civilization from one generation to another. I am sure I can write a book and ought to do it.

20. The prisoner is guilty, for he has all the marks of the natural criminal and was the only person seen near the place where the crime was committed.

CHAPTER XIII

PROBABILITY

The tendency of the ordinary mind is to exaggerate the degree of certainty attached to its judgments, because certainty is a signal for action, and action brings desired results, while uncertainty calls for delay and toilsome reconsideration.

Certainty is a state of mind, when considering a judgment, devoid of a conception of possibility of fallacy. Uncertainty is caused by the presence of an opposing judgment entertained as a possibility. Certainty attends axioms, judgments based upon immediate perceptions, and completely demonstrated propositions.

The weight of opposing judgments, causing uncertainty, is exceedingly variable, passing from zero to infinity. The relation between these two factors of certainty and uncertainty is called *probability*.

In practical situations we cannot usually wait for absolute certainty, much as we should like it. We must act upon what information we have, even when some of it is contradictory in character. We must then determine, as well as we can, the probability of the truth of the judgment which is to form the ground of our action. We are compelled to "calculate the probability" of the success of our proposed plan.

To make such a calculation, we find out, as thoroughly as circumstances permit, the conditions bearing upon the judgment under consideration. These we array, and try to estimate the weight each will have, and from these data we strike a balance and declare the degree of probability of the truth of the judgment. This states the "chances" we are to take by acting as if the judgment were true. We then decide whether to act or not.

We eat the customary food placed before us in full confidence that it will nourish our bodies. If, however, an unheard-of dish, unattractive in appearance, is offered us, we will probably hesitate and may refuse to eat it until doubt regarding it is removed by assurance offered by someone we trust. Theoretically, we know the familiar dish can contain deadly poison, and the new one may be better than anything we ever ate; yet we gropingly estimate the probability in each case and act accordingly.

And so it is throughout life. Constantly we are driven to deal with probable judgments as the basis of our dealings, even when they come to us in the form of universal propositions which presumably are beyond doubt. This being true, it is highly important that we acquire such skill as we can in calculating the probability of our judgments.

In very simple situations the task of calculating probability is easy enough. We know a coin, having two faces, must fall with either head or tail upward. From that knowledge we assert that the chance of it being the head in any given instance is one to two, which probability is expressed by the fraction $1/2$.

Likewise we conclude that a given event happened on a certain day of the week has a probability of $1/7$, and the probability of the ace being up when a die is cast is $1/6$. Thinking a little farther we see that the probability of throwing two aces in succession must be $1/6 \times 1/6$, or $1/36$, and that of any similar series would be estimated in the same manner. These calculations can be verified by actual experimentation. Such calculations may be made only when the total number of possibilities can be known.

The more important situations in life are not so simple. They call for elaborate investigations and calculations if we are to attain anything like accurate statements of their probability. If we try to formulate an exact statement of the probability that rain will fall at a given time and at a given place, it can be made, but not easily. If weather observations have been made from which we can find the number of times rain *has* fallen under such conditions, and we use that number as the numerator N , then take the number of times when it *might have* fallen, D , as the denominator, the resulting fraction, N/D , would indicate the probability of the event occurring. The number of observations from which the data were drawn must have been very large—large enough to have been affected by all the possible conditions that might have any bearing upon the event. Since some of these conditions may be quite variable, coming and going imperceptibly, their influence on the occurrence of the event can only be assumed to have been felt when a very large number of instances have been counted into the calculations.

The task of thus calculating the probability of a given event becomes almost infinitely difficult when we have to deal with events that are decided by a great number of indeterminate factors. To calculate with certainty the probability of the success of a military campaign, of a business enterprise, or the chance of election to office, is impossible, although we try to do it because we are compelled to. However difficult such problems are, we have to pretend to solve them and then act upon our solution, because they constitute the inevitable environment of our daily lives.

The inevitability of losses we are compelled to sustain because of our ignorance of actual conditions, and therefore of our inability to attain complete certainty of judgment regarding them, has led modern society to adopt measures of "insurance" against them. And yet this method of protection brings us no greater certainty of judgment than we have without it. So-called insurance merely enables us to distribute losses among many people, giving to each a small loss instead of a large loss to one. The logical calculation of the probability of the loss falling naturally upon one person is the basis of such distribution. Any man knows his house is not prevented from burning by having it insured; indeed statistics show the probability of its destruction by fire is thereby increased. Nevertheless, no man of good business judgment will fail to buy a fire insurance policy for his house. By doing so he voluntarily incurs the loss of the premium he pays, but he secures protec-

tion from a much larger loss should his property be destroyed.

This method of substituting a certain small loss for an uncertain large one has been adopted in a great many activities, although the aggregate loss sustained by the group involved is increased by it. The basis of all insurance schemes is the calculation of probability of losses. The science of such calculations has become an important branch of mathematics. A person whose profession it is to make such calculations is called an "actuary." Insurance in its many phases has become one of the largest departments of modern economic life. It takes its place by the side of manufacture and commerce, and is devoted solely to the distribution of losses so large that they cannot be borne individually among many who can afford to bear them collectively.

While men have gone so far in their efforts to diminish suffering from loss flowing from the necessary uncertainty of their judgments, it is interesting to note that, quite inconsistently, they wilfully incur such risk even when not required by the conditions of their lives. They even deliberately create uncertainty and assume the risk resulting from it. Some men insure their houses against fire, flood, and storm and then sit down in them and engage in games of chance. So a man may be a cautious man of business and a profligate gambler at the same time, so inconsistent and illogical is the natural man.

To gamble is deliberately to appeal to chance, to risk that which has value upon an uncertain judg-

ment. It is done in the face of the known fact that loss is at best as probable as gain. The chief motive for indulgence in games of chance is the prospect of emotional excitement which attends it. This is so keen in some individuals that they are incapable of resisting the temptation to indulge in them. Commercialized gambling decreases the probability of winning by placing a fixed charge on the transaction. The man who conducts the game does so in such a way that, by the law of probability, a small but certain profit comes to him. Indeed, he is engaged in a business enterprise quite like an insurance company. The difference is that he is creating a hazard which men pay for the privilege of assuming, while the insurance company is aiding prudent people to avoid risks which they otherwise would be compelled by nature to incur.

Much of what is called gambling is in fact competition in skill between the participants. More frequently, however, games which involve financial risk combine both skill and chance. In so far as they turn on the skill of the players they are not, strictly speaking, gambling.

EXERCISE 34

Estimate the probability involved in each of the following? How is it determined?

1. My being alive a year from today. Five years. Fifty years. Five hundred years.
2. My automobile being burned during the coming year. Being stolen. Being wrecked.

3. The heads of five coins being up when they are all dropped at once.
4. The sun being visible from here next Saturday.
5. A home-run by Babe Ruth. By the average amateur.
6. A certain question being asked in an approaching examination.
7. The success of M— in a given profession. Of N— in some other profession.

PART IV

THE PATHOLOGY OF THINKING
RESULTS OF THINKING

CHAPTER XIV

THE PATHOLOGY OF THINKING

Interesting as may be the processes of the mind in its attempts to acquire truth, it is much more important for us to acquire practical skill in employing them than it is merely to know about them. So valuable to us is knowledge of truth, and so expensive and dangerous is error, that the most ordinary prudence requires that we embrace any opportunity to advance our skill in securing the one and avoiding the other. As an aid in this undertaking, a review of the numerous, best-known sources of error seems to be advisable. The following discussion of the fallacies to which thinking is prone includes many already encountered in our previous study.

Innate Stupidity.—Probably the chief source of error in thinking is native stupidity—sheer lack of intelligence. No person is equipped with a perfect mind. The best minds are sadly limited in their powers. To err is human. The simpler mental acts, like perceiving and comparing things so perceived, are the most trustworthy, but even they are often erroneous. The higher processes, involving prolonged trains of thought and scientific systems, are so difficult that they are employed rarely by many of us and are used effectively by few. Those who

successfully carry on these higher thought processes inevitably become the intellectual leaders of others. *Brains win.*

A sense of intellectual incompetence is given to all of us in some degree, but the vigor of its warnings is not a reliable guide to the extent of our stupidity; Socrates protested that the only thing he knew was that he knew nothing. In *Much Ado about Nothing*, Dogberry exclaims, "Oh, that I had been writ down an ass!" The self-condemnation of Dogberry was probably no more sincere than was that of Socrates, but it was more merited. There are moments when we can all sympathize with both of them. The limitations of the native human intellect are so great the wonder is that people get along as well as they do. Happily the world is so constituted that no one need despair of a career of usefulness because he has not been endowed with a brilliant mind.

Intellectual Indifference.—Frequently the obstacle to the acquisition of truth is mental indifference. This might almost be said to be the normal state of all minds toward many facts. Indeed, most facts do not interest us at all. Only the significant ones do and those which promise us some practical advantage.

Minds differ greatly in their ability to anticipate significance. To one mind a given fact seems to stand all alone in the world, devoid of meaning, and it is therefore ignored; to another, the same fact is quickly seen to be indissolubly bound up with another, or a system of many others, of the highest

significance and deepest interest. One of Huxley's most interesting papers is entitled "A Stick of Crayon."

An indifferent mind may stand unimpressed before a fact while a penetrating mind, recognizing the interdependence of facts, is able to anticipate the fruitfulness of that fact, and to give to it a correct valuation and appreciation. Such a mind is hospitable to new facts and consequently is continually being enriched by additions to its store of knowledge.

While by most people the value of a truth is decided by utility, there is a type of mind, that of the pure scientist or the true philosopher, which is deeply concerned about truth as such, without regard to its practical consequence. Although such unmixed curiosity is not so rare as to occasion surprise, in most of us it is neither very durable nor very influential.

Preference for Accepted Beliefs.—Then there is the case of ignorance preferred. It does not sound probable, but it is nevertheless true, that people exist who prefer falsehood to truth, people to whom ignorance is bliss. A pleasant falsehood can hold out a long time against an unwelcome truth in many a quite intelligent mind. A well-known resident of Chicago has long had a standing offer of ten thousand dollars to anyone who would convince him of the rotundity of the earth. There is slight prospect of anyone winning the prize. The refusal of people to accept modern truth, although scientifically established, is the result of a preference for the old beliefs because they have become endeared through

long association. Is there one of us who can be confident that he is wholly free from this disposition to hold fast to an old error rather than to have it displaced by a new truth?

This holding on to old but discredited beliefs through sheer mental inertia accounts for most superstitions. When it is attended by an unusual degree of self-complacency or pride of opinion, as it often is, it deserves the name of bigotry.

Emotional Disturbances.—There is a very old saying that "Whom the gods wish to destroy they first make mad." The real meaning of this is that anger so disturbs the normal mental processes that conduct ceases to be directed by reason and falls into such blunders that ruin follows. Poetically minded persons may attribute the unfortunate results to the gods, if they like, but there is a far more inexorable force engaged in executing the decree than the whimsical deities portrayed in antiquated mythology. Nature does this and always will do it. Possibly not in the same degree but in some measure, nevertheless, is this true of many emotions other than anger. Even love is reputed to be blind. These feelings may provide motives for thinking, but they are able to give it false direction and unworthy purposes. A great Greek philosopher welcomed age as a release from the passions which had previously dominated his life. For with that relief he was confident would come the opportunity for clear and unprejudiced thinking and therefore worthy living. The "passionless sage" of the ancients was properly regarded as their safest thinker.

Personal Coefficient.—Although people are very much alike in many respects, probably there are no two persons who do not differ in some important characteristics. Each one has his own personal peculiarities which twist his mental processes in some way and to some degree. These peculiarities may have been with him from birth or they may have resulted from habit. Whatever their origin, they are actual and they seriously modify his mental life. Each one should know his own peculiarities and his personal bias. Just as we should know our physical peculiarities, especially our organic weaknesses, we should know our personal mental predilections, so that we may take account of them in our thinking, which is colored by them. Prejudice, growing out of such personal idiosyncrasies, has been the foundation of error, of bigotry, of cruelty. Each person should have his own personal coefficient to introduce in all his efforts at right thinking.

That indefinable something we call “temperament” has much to do with the thinking of its owner. And the predominant moods which we all submit to are constant disturbers of the efforts of our intellects to find and to hold on to the truth.

Intellectual Mendacity.—“All men are liars.” This is an alleged empirical law long ago derived by observation. That many men were liars when this was first proclaimed and that some men are liars still, no one can question; but even the term “liar” is infected with ambiguity. Just what is a liar? Anyone who wilfully asserts an untruth certainly is. There is such a thing, however, as unintentional

mis-assertion, coming from minds congenitally so misshapen that they are ignorant of their own falsification. Practically they may be as dangerous as real liars, since they may mislead innocent persons by their assertions. They may be even more dangerous since they may be more plausible. The true liar falsifies knowingly for profit or other selfish end. The person who makes untrue assertions because they flow from a perverted intellect may have no intention of misleading his fellows although he does it—he even misleads himself.

Intellectual mendacity is the characteristic of a mind which unwittingly traverses a curve, so to speak, when it should follow a straight line. Many conscientious persons have such minds. Even certain scientists and historians, queerly enough, have been suspected of being crippled in this way. Of course, their work is soon under suspicion and is discarded or worked over by their associates who are not so afflicted. To be known as being intellectually honest is a consummation devoutly to be wished.

Ignorance of Logical Principles.—Whether they think well or ill, few people understand the scientific principles underlying their thought processes. They just think on in full confidence that their manner of thinking is trustworthy. The student of logic knows only too well the numerous chances of going wrong without being aware or even suspicious of the invalidity of his thinking. Only the most scrupulous observance of these principles can protect any thinking from fallacy. No wonder there is diversity of opinion and conflict of argument whenever men meet.

Excessive Confidence in the Simplicity of the Universe.—Progress in human knowledge is revealing an ever-increasing complexity in the universe. Primitive man knew many facts of which his modern descendant is ignorant, but compared with the intellectual possessions of the latter, his list of known facts was pitifully meager. And his system of principles supporting his facts was correspondingly contracted and absurd. Consequently the world of the aborigine, judged by the modern, was ridiculously simple. With the years the world has grown increasingly complex, yet it will still be ridiculously simple probably, when it will be judged by the wisdom of future times. This common assumption of a natural order as vastly more simple than it actually is, must be a constant source of error in the thinking of all of us. To realize our mistake, however, may enable us to avoid some of the error into which we would otherwise fall.

Excessive Confidence in the Applicability of Theory.—The theories we adhere to are but hypotheses which have stood through some tests to which we have put them. Naturally we are inclined to be hasty in our acceptance of plausible hypotheses as universal principles after they have proved applicable to experiences through which we have passed. Then we go on in the faith that they will apply to all situations which seem to be similar. This proneness to assume a broader field of application for the theories which have given some evidence of validity is a common source of error in our attempts correctly to understand the world about us. The danger of

such error is perhaps most common when we are thinking about human affairs, like social, political, and economic matters. *Practical* men are given to denouncing certain types of thinkers as *theorists*, and not without some reason; but they themselves are probably as prone to overwork their own hypotheses as are those they criticize.

Obscurity of Diction.—At best, language is a poor medium for expressing thoughts. To employ it with a reasonable degree of success requires skill beyond that possessed by most people. There have been rare artists in this task of putting complicated thought processes into words. There have been intellectual geniuses, however, who have been greatly handicapped by sad deficiency in this capacity for linguistic expression. Ability to think originally and ability to express thoughts clearly are not always possessed by the same individual.

Obscurity of style causes much misunderstanding. This defect, leaving the reader mystified as to the exact meaning of the writer, has even been taken as evidence of profundity, the reader taking the blame for his failure to understand by pleading his own stupidity. The fault was more likely the writer's sheer clumsiness in expression. This fault has affected many great thinkers. One of the best known of these was the philosopher Hegel. The following sample of his turbid style, which might have been taken from almost any one of his thousands of pages, will leave the reader quite in doubt as to the writer's meaning. It is the first paragraph in the discussion of "The Object" in his *Logic*:

The Object is immediate being, because insensible to difference, which in it has suspended itself. It is, further, a totality in itself, whilst at the same time (as this identity is only the implicit identity of its dynamic elements) it is equally indifferent to its immediate unity. It thus breaks up into distinct parts, each of which is itself the totality. Hence the object is the absolute contradiction between a complete independence of the multiplicity, and the equally complete non-independence of the different pieces.

Now contrast the foregoing with a typical paragraph from Huxley, in his *Lay Sermons*:

Descartes stopped at the famous formula: "I think therefore I am." But a little consideration will show this formula to be full of snares and verbal entanglements. In the first place, the "therefore" has no business there. The "I am" is assumed in the "I think," which is simply another way of saying, "I am thinking." And in the second place, "I think" is not one simple proposition but three distinct assertions rolled into one. The first of these is "something called I exists"; the second is, "something called thought exists"; and the third is "the thought is the result of the action of the I."

Clear thinking is always jeopardized, if not nullified, by obscure diction. The disciples of Hegel disagreed radically in their interpretation of the master's words. Later the number of his readers increased who believed that much of the time Hegel really had no clear meaning to express and therefore unwittingly chose seemingly senseless phrases.

Ambiguity of Diction.—Similar to obscure diction is the use of words and phrases which are ambiguous or equivocal in their meaning; that is, the expressions

employed have more than one meaning. When one of the meanings is in the mind of the reader, and the other is in the mind of the writer, misunderstanding is unavoidable. This source of error is so common that no one will have difficulty in supplying numerous appropriate examples. A very practical question may arise as to who is properly responsible for such misunderstanding.

A special kind of ambiguous diction results from a dual use of some words as both general and collective terms. The shocking report that in a certain land the mosquitoes were so large that many of them weighed a pound was relieved by the reply, "Yes, it took a great many to weigh so much." It has been estimated that one-third of the current jokes turn on multiple meanings of words. In these cases, however, no misunderstanding results.

A very common example of uncertainty of meaning due to ambiguous or equivocal terms is found in the headlines of modern newspapers. Uncertainty in the field of application of a term or proposition that is assumed by either speakers or hearers is a prolific cause of ambiguity.

Diversity of Purpose or Changing the Issue.—To think without a definite end to be attained is to think futilely except as good fortune provides the conclusion. The end in view is often made indefinite by the presence of diverse purposes which are allowed to succeed each other during the process of thinking. When the issue thus changes—when one purpose is substituted for another—nothing can be established and only confusion can result. That the

parties to the argument are ignorant of such transposition of purpose only makes the matter worse.

Some historic examples of the fallacy of changing the issue or purpose are the following:

Argumentum ad hominem (appeal to personal interest) makes an appeal to personal interest and prejudice while pretending to establish the truth. It is often encountered in the court room. Mark Antony's announcement of the will of Cæsar was an example of this.

Argumentum ad populum (appeal to popular prejudice) appeals in a similar manner to popular prejudice and interest. It is the politician's favorite fallacy. A vast number of the arguments published during any war belong here.

Argumentum ad ignorantiam (appeal to ignorance) deliberately takes advantage of the ignorance of the person whom it is sought to convince. "If you do not know it is not true, then we may assume it is true." This clearly is sophistry. It is frequently employed in salesmanship.

Argumentum ad baculum (appeal to force) is the practical abandonment of all logic and the substitution of force and intimidation. It is the great temptation of those who are in positions of authority. It has been found in discussions regarding politics, society, theology, etc. The nations of the earth are trying as never before to avoid this fallacy which has been prevalent in international affairs from time immemorial. The boasting song declaring the fact that "we've got the men and the money, too," is an exhibition of *argumentum ad baculum*.

Fallacies in Division and Classification.—In attempting to divide the denotation of a genus into its species, the species may be so chosen that when added together they are not exactly equal to the genus. This inequality may result from the sum of the species being less than the genus, which happens when some of the denotation has been omitted. Or the inequality may result from the sum of the species exceeding the genus. This comes from the overlapping of species so that the same things will be counted more than once. Or species may be chosen which include some things entirely outside the genus. The systematic sciences find great difficulty in keeping themselves clear of this fallacy.

Fallacy in Definition.—Successful thinking is impossible unless the terms employed are definite in their meaning. This requires that they be precisely defined. Failure clearly to define terms leads to much error. So often what passes as definition is merely a partial description. There is no adequate substitute for the *logical definition* with its two component parts, namely, the location of the term to be defined in a known, near, larger group or genus, and the naming of characteristics peculiar to the term itself and which therefore distinguish it from all the other members of the genus.

The famous definition of man as a “featherless biped” was absurd and doubly fallacious since biped is too large a class for the purpose and the absence of feathers is not a characteristic of man only among the bipeds.

Fallacious Conversion.—Not rarely we start thinking from an *A* proposition and thoughtlessly use it converted simply, whereas if we have occasion to use it converted, the only thing it can become with certainty is an *I* proposition. From the assertion that “All the members of my party are devoted to the country’s welfare,” it is easy to pass to the converse that “All patriotic citizens belong to my party.” Such loose thinking is easily detected, but it surprises us sometimes in places where we do not expect to find it.

All attempts at the conversion of the *O* proposition are fallacious. “Some X’s are not A’s” is not true simply because “Some A’s are not X’s.”

Bad Observation.—To observe successfully a person must perceive the unwelcome as well as the welcome fact; he must perceive the apparently unimportant fact as well as the apparently important; he must perceive the intrinsically uninteresting fact as well as the interesting; he must perceive the obscure and the novel as well as the obvious and familiar; he must ignore nothing, and he must be a realist at every turn. To fail in any of these respects is to risk committing fallacy. But that is not all. To fail properly to select and use the facts gained by such observation—to fail to recognize and mentally to record and interpret them accurately, however carefully they may have been acquired, is to commit fallacy.

Hasty Induction.—A vast deal of error comes by generalizing from too small a number of similar

instances or from the choice of an unessential characteristic as the ground for induction. Induction, properly conducted, is a time-consuming process, and many people are unwilling to give much time to it; they therefore hasten to their conclusions only, later, to find them false.

The succession of popular methods for treatment of disease results from hasty generalization regarding their efficacy from a relatively small number of instances of treatment.

False Analogy.—Reasoning by analogy is always attended by serious risk. Conclusions so drawn have value only as hypotheses, not laws that can be trusted. The fact that two things are alike in one respect, that is, that they have some characteristic in common, suggests the possession of other common characteristics; but the suggestion must be verified or it is very liable to prove fallacious. Because the whale resembles the fish in so many ways makes it astonishing to find that the one is a mammal and the other is not, but it is none the less true.

False Cause.—Probably the commonest error in all our thinking, of serious practical importance, is the assignment of the wrong cause to a known phenomenon. Always there are so many apparent circumstances which seem to be conditions, and of these latter it is so easy to select one and regard it as the cause, and it is not surprising many mistakes are made. And there are so many and such potent influences at work leading us to prefer one of these circumstances as cause! Only the prevalence of the true scientific spirit—the mood and habit which

demands the unconditional truth—can ensure our safety from this fallacy.

Assuming the Conclusion.—When we have a conclusion in mind which we wish to prove we frequently make the unconscious mistake of assuming this conclusion, either partially or entirely, and using it as a foundation on which we base our reasoning toward that very conclusion. One way of doing this is merely to state the conclusion in different words and use this statement as an assumption from which to reason. This leads nowhere, for mere reiteration is not argument. Another way is to use qualifying adjectives or terms in our basic material whose use virtually takes for granted the conclusion awaiting proof. Not infrequently a conclusion is drawn from premises, one of which depends upon that very conclusion or upon still another proposition which flows from it.

This is the fallacy sometimes called “Begging the question” or “circular reasoning.” An example of this is shown in the following: It has been argued that biological species cannot have a natural origin because of the fact that descendants from the crossing of species, called hybrids, are infertile and therefore incapable of continued propagation. This is a case of begging the question since by definition a species is regarded as a group so distinct from other groups that crosses between them are infertile.

Affirming the Consequent or Denying the Antecedent.—In the hypothetical syllogism to use a minor premise which affirms the consequent and to draw a conclusion affirming the antecedent is to

commit fallacy. Similarly to deny the antecedent in the minor premise and conclude the denial of the consequent commits a fallacy. Note the following:

If the United States recognizes the Soviet government of Russia, communism will spread throughout the world. But the United States will not do this. Therefore, communism will be prevented from such extension of its sway. *This is a fallacy of denying the antecedent.*

Whenever there is an unusual number of spots present on the sun's disk, there are violent electrical disturbances on the earth's surface. During the night such electrical disturbances occurred. There must have been such unusual conditions on the sun's surface. *This is a fallacy of affirming the consequent.*

Incomplete Disjunction.—When the disjunction in an alternative proposition is incomplete, that is, when the predicates are not mutually exclusive, any conclusion based on such mutual exclusiveness must be unreliable. This mutual exclusiveness is the principle upon which the alternative syllogism is based. For example:

To be elected to high office a man must be personally popular or a true statesman. The chosen candidate is the most popular man of his time; therefore, he is not a statesman. *This is clearly an error, for he might be both a statesman and a popular personage.*

Fallacy of More Than Three Terms.—The two terms of the conclusion of a syllogism, the minor and major terms, have their known relation disclosed

by means of a third or middle term. Confusion due to language indefiniteness may conceal the fact that this mediating term is not the same in the two premises and that there are, in fact, two such terms passing as one. In such a case there can be no real relation established between the minor and major terms as they appear in the conclusion.

In a similar manner there may be confusion in the minor and major terms as they occur in their premises and the conclusion. This is a fallacy which might be regarded as coming under that of *ambiguity of diction*.

Undistributed Middle.—The middle term of a syllogism, being the medium of comparison between the major and minor terms, must be used *for all it is worth* in one premise at least. In the following syllogisms this is not done and the conclusion fails to follow:

Wages are governed by the law of supply and demand.

The money I have just received is wages for my work.

Therefore, the amount of this money was determined by the law of supply and demand.

The middle term “wages” is not distributed as it must be to make the conclusion valid.

Illicit Process of the Minor or Major Term.—To use distributively either the major or minor term in the conclusion when it is undistributed in its premise, is to assert that what is true of a part of the members of a group is true of all of them. This is palpably

unwarranted. To do this is to commit the fallacy of *illicit process of the major or minor term*.

An example of illicit major would be:

All Saxons are Germans.

No Belgians are Saxons.

Therefore, no Belgians are Germans.

The conclusion here may be true in fact, but it does not follow from these premises. The major term, "Germans," being the predicate of an *A* major premise is not distributed and cannot be used distributively as it is in the conclusion.

The following is an example of an illicit minor:

All Methodists are Protestants.

All Methodists are Christians.

Therefore, all Christians are Protestants.

No assertion is made about "all Christians" in the minor premise.

Fallacies of the Dilemma.—The dilemma, based as it is upon a double hypothetical proposition as a major premise, is subject to the fallacies of the hypothetical syllogism. Since the minor premise is an alternative proposition the fallacies of improper disjunction are also possible. Add to this the fact that the dilemma is a highly complicated form of argument and it is easily apparent that to make use of it with certainty of valid conclusion is extremely difficult. Few people are capable of employing the dilemmatic form of argument with accuracy.

A citizen in doubt as to whether to vote for Coolidge or Davis argued:

If I vote for Coolidge, I shall be supporting a conservative domestic policy; and if I vote for Davis, I shall be favoring a change in our foreign policy.

Either I shall not vote for Coolidge or I shall not vote for Davis.

Therefore, I shall oppose the conservative domestic policy or favor the present foreign policy.

This is a fallacy of the *denial of the antecedent*.

If the party platform endorses a protective tariff, the manufacturers will support the ticket; and if it approves the child labor amendment, organized labor will support it.

One of these measures will be favored by the platform.

Therefore, the ticket will be supported either by the manufacturers or organized labor, and its success will be assured.

The foregoing dilemma is valid except the last clause which does not appear in the premise. If, on the other hand, the minor premise adopted had been:

The ticket to win must be supported by either the manufacturers or organized labor.

Therefore, either a protective tariff or the child labor amendment must be endorsed,

the dilemma would be invalid, since the argument is based on the *affirmation of the consequent*.

Most fallacies growing out of the use of the dilemma are due to the unreliability of one or the other of the premises. The conditions which they presumably represent are so complicated that while they seem to be beyond doubt, one or the other is in some degree untrue or they do not represent the whole truth of the matter.

A successful employment of the dilemma requires much patience, broad learning in the field under discussion, and a thorough knowledge of the logical principles obtaining in the dilemma.

Non-sequitur.—This is one of the most famous of logical fallacies and one of the most obscure. It is a fallacy in which the conclusion drawn from the given premises is found to be unexpectedly untrue, without any clear ground for being so. This failure of the expected conclusion may be due to the insidious violation of some of the many rules of logic, although all those rules seem to have been observed. Or it may be due to the fact that the conclusion just happens to be an exception to the apparent universality of one of the premises, not to be foreseen until this same conclusion was drawn. The appeal to actual fact, after a conclusion has been drawn, often reveals the existence of a *non-sequitur*.

The apparent conclusion that a period of hard times, occurring during the administration of the government by a given political party, was the effect

of the principles professed by that party, may be a *non-sequitur*, although a crude one.

An absurd but somewhat annoying example of the same fallacy is the old:

No cat has nine tails.

One cat has one more tail than no cat.

Therefore, one cat has ten tails.

CHAPTER XV

RESULTS OF THINKING

Thinking goes on. Sane or insane we continue to think. Whether we are sane or insane depends upon the nature of our thinking. As the heart keeps beating and the other organs of the body continue to function, each devoted to its own peculiar task, so the brain goes on doing whatever it has to do, as long as life lasts. One of the results of this activity of the brain is thinking.

It has been shown elsewhere that the power of thinking, like other powers, has developed as a necessary means to successful adaptation of the individual to its environment. Without the ability to think, a person dies just as he does when he loses his ability to digest although not so quickly, perhaps, because others can do some of his thinking for him.

Some of the more significant results of thinking are Understanding, Explanation, Science, Philosophy, Prediction, and Intelligent Living.

Understanding and Explanation.—To the youthful mind, especially, the universe appears as a sea of question marks. Everything presents a problem—or, rather, it presents many problems. What? When? Why? Whence? How? and many other questions may attach themselves to every perceivable

thing, and to all subjective experiences as well. The longing to have these questions answered is the desire to understand. *Understanding* is a state of mind brought about by getting satisfactory answers to these pressing questions.

There are differing degrees of understanding, depending upon the thoroughness of the development of the subject by the questions asked and the answers given. Sometimes we are easily satisfied and assert that we understand when, in fact, we know very little about the matter. Only minor questions or few of them, easily answered perhaps, have been considered, and when we have replies for them—very superficial replies, it may be—we believe we understand, but do not. An ignorant man may say he understands why it is raining, for he saw a dark cloud come up from the west. A trained meteorologist with all his technical knowledge, a thousand fold more voluminous and precise, may still hope to be able some day to understand completely why rain falls.

It has already been shown that to discover one fact is to raise several questions. The more we know, the more we know we do not know, and the more difficult it is, therefore, for us to arrive at what we consider a state of complete understanding. This is the predicament of the scientist, the man who demands all knowledge of all the facts in his field. Perfect understanding would involve an exact knowledge of the nature of a thing and of all its relations to other things, and all this arranged in a logical system.

For practical purposes we face in any particular

case only one or two questions for which we are probably willing to accept quite incomplete replies, and then we do not allow ourselves to ask further questions. By this means, and in that meager way, we do understand many things. Usually the question that is most certain to be present is the one regarding the cause and the conditions of the phenomenon under consideration. To explain the cause of a thing usually is enough to lead to what passes as understanding. *Explanation* is any statement which leads to the state of mind called Understanding.

Science.—Some men have always known more than others. Some have had superior opportunities for acquiring knowledge, have had superior ability to observe successfully, have had superior ability to think successfully. And the more wise ones have always had an advantage over the less wise ones. *Knowledge is power.*

As superior knowledge brings advantage, the pretense of it may also. Naturally we all accord to the man that is reputed wise a position of influence and authority. The desire for such social recognition has been a great stimulus to the struggle for the attainment of knowledge and also to the pretense of it. Nor could the ignorant help themselves, since they could not know who of their fellows were truly wise and who were only pretending to be so.

The life of Socrates was devoted to the testing of men as to the genuineness of their wisdom. As he found that much of what then passed as true wisdom was spurious, so in our own day there is much error

that passes current as real wisdom. That there is widespread suffering on account of it does not end it either. The enemies of Socrates thought that by destroying him they could avoid being examined for the truthfulness of their beliefs, but they were mistaken. Life, as it must be faced, is forever testing us in a much more merciless way.

Because of the disastrousness of error, intelligent people have always tried to get at "the truth, the whole truth, and nothing but the truth." In recent years this systematic search for the truth has become a profession, so essential is it regarded. Those who follow it are *scientists*, and the results of their efforts constitutes what is known as *science*.

Science is the aggregation of the several separate sciences. Each of these sciences consists of the known facts within a certain naturally limited field of reality after they have been reduced to an intelligible system. The process by which such facts are obtained is observation and the process by which they are organized into a system is thinking. So science—all the hundred and one sciences—is one of the results of thinking and one of its most momentous results.

Out of ages of experience and thought have come a great mass of accepted facts and the principles embracing those facts. Many of these facts and principles have stood the tests which life has brought. Many are accepted and preserved because they are pleasant to believe. Science starts with the assumption that Truth is good and is to be prized, but Error

is bad and is to be discarded. Science, therefore, devotes itself to enlarging the store of known truth and to the exposure and abandonment of falsehood.

Science hesitates to recognize any suggested fact or principle until it is thoroughly tried by being fitted into the established system of known facts and principles. When it does so fit in and becomes an integral element of that system it is accepted as true. The chief aims of science are the actual disclosure of facts and their systematization. Isolated facts, however great the number, are but the data, the "given," from which the great body of science is built up. Science takes these facts and organizes them into a logical system as rigid and dependable as possible. More than that, science refuses to be concerned with merely suggested or alleged facts. To be of interest to science, an assertion must be true and demonstratively so. Science uses hypotheses and theories but as means to the attainment of knowledge that lies beyond all doubt.

The significance of science as a factor in modern life is beyond the comprehension of most of us. It is the foundation of the best of civilization and the hope of progress. Perhaps some conception of its range and complexity could be gotten by making a tabulation of the various sciences which, taken together, constitute science.

Philosophy.—The Greek sophists came under the severe condemnation of Socrates, as he denied their possession of much real knowledge, asserting that what they claimed to be knowledge was nothing more than opinion. He distinguished between them and

himself by saying that they pretended to have knowledge and didn't, while he knew he had it not, although he loved it devotedly. Being a lover of wisdom, he was willing to be called a philosopher but not a sophist.

There have always been philosophy and philosophers. The philosophers have been great thinkers. Indeed it might almost be said that those who have been regarded as the supremely great thinkers are those who have been honored by the title of philosophers. The self-imposed task of the philosopher might be said to be the complete rationalization of the universe, and thereby its complete understanding.

That much of the best work of the philosopher seems to have no practical value, and is regarded indifferently by the mass of his fellows, is natural and inevitable. It was just because philosophy operated on so large a scale that, with the increasing of the knowledge it embraced, it had to be differentiated into the various sciences. Division of labor became necessary. Every science has had its beginning in philosophy and its underlying assumptions have come from that source.

The philosopher set out to comprehend the universe in its broadest outline, to reduce it to incontestible principles; the scientist hopes to work out an increasingly broad conception of detached areas of reality. Both scientist and philosopher have had the same ultimate goal, the acquisition of all possible knowledge. They have used the same instrument, the power of thought. Presumably they

have both observed the established principles of valid thinking, the *laws of logic*. They have been equally misunderstood and misrepresented by those who did not know or did not care or were afflicted with hopeless, congenital stupidity. Sometimes, unfortunately, each has failed to appreciate the purposes and accomplishments of the other.

Prediction.—Over and over again in these pages emphasis is given to the assertion that facts are the most valuable of our practical possessions and that to acquire them is the object of our best labors. Not all facts have such importance, it is admitted—only those which serve our purposes.

Now in spite of the scriptural injunction to the contrary, we are all anxious with regard to the morrow. The present moment, with the facts which make it what it is for us, may be of greatest concern to us; but we are also concerned about the moments which are to follow this one, running out indefinitely into the future, with their conditioning facts.

“Tomorrow, and tomorrow, and tomorrow,” forever cast their shadows over today. To ignore their appeal is to be guilty of grave imprudence. Future events—the facts that are to be—as they shall serve as conditions for our lives when we get to them, may be even more interesting to us than the present ones. To know them in advance may be to assure ourselves of safety and satisfaction; it is, at least, to be forewarned if not forearmed to meet them.

It was this anxiety for the future which gave such prominence to the gift of prophecy among primitive peoples. There have always been the unusual

persons who had, or were supposed to have, this extraordinary power of divination; and those who made claim to such peculiar power naturally were accorded honors and privileges beyond their fellows.

Every intelligent being has some degree of power of forecasting events. Indeed, that is the chief function of reason—the good of thinking. Rightly or wrongly, we are always assuming what events and conditions will occur next instant, an hour later, or a day or a year, and these assumptions are the ground of all our actions. These ideas of future facts are obtained as conclusions from our reasoning processes—our *thinking*.

In the more primitive sense, prophecy is “intuition” or “revelation,” applied to the future. Only the test of time will determine whether such alleged prophecy is genuine. When, however, the predicted event is found by logical methods to follow inevitably from known facts and laws, its occurrence is assured in advance. For example, the astronomer foretells the future positions of a comet, newly appeared, after he has made a few observations of its changing position. From a very few points, he calculates the nature of its orbit and its rate of progress, and from these facts forecasts its position at any given future time.

Less accurately, yet accurately enough for many purposes, we set the time when many events will occur. But we are sadly handicapped in our attempts so to foretell the future. If we could accurately foreknow the weather six months in advance, or the prices of marketable commodities, or political

happenings, what a stupendous advantage we would have! As it is, the person who can think most accurately and can do the most thorough job of it, is the person who knows most about the future; this is the person who has the greatest advantage in all practical undertakings; this is the person who succeeds when others fail.

EXERCISE 35

Analyze the logical process in the attempt to predict

1. The outcome of an athletic contest.
 2. The result of an election to a high office.
 3. The price of a selected commodity.
 4. The result of a military campaign.
 5. The re-appearance of a comet.
 6. The effect of a given drug upon one who is to take it for the first time.
 7. The yield of a crop just being planted.
 8. The time of the arrival of a train.
 9. The political situation one hundred years from date.
 10. The distance to the sun a year from a given date.
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Intelligent Living.—Our simplest acts are altogether mechanical. They result from the fact that our muscles have become definitely adapted to the practical demands that are made upon them by their environment. We breathe, eat, walk, strike out against threatening objects, without any attention to, or conscious direction of, our conduct.

Such activities lie at the very foundation of our physical existence. We have these experiences in common with the lower animals.

Lying close to these purely mechanical activities, called "reflex actions," there is another type of activity which is the expression of so-called "instincts." These are definite tendencies to conduct which are racial habits, apparently inherited by the individual and exercising powerful control over him. We play, fight, love, save our money, organize societies, and do a thousand other things, because there is built into our very nature a tendency to do these particular things. Instinctive impulses are almost all an advantage to the individual and help him in his career. Some of them serve humanity as well as they do him, and a few benefit the race while requiring sacrifice from the individual.

Now, instincts are mechanical controls of human conduct, but they share in some measure their authority with conscious volition. A human being may yield to the instinct, with which he is endowed, to injure or destroy another who interferes with the execution of some plan. A recollection of a previous experience, or many of them, and a little reflection may cause a person to resist this command of instinct to pursue such a dangerous or disreputable policy. This is the voice of *reason*, entering by a process of *thinking*, upon the scene where deeds are being determined.

It may be, as certain psychologists have maintained, that reason can only array one native impulse against another and cannot provide an opposing

force itself. However that may be, reason can, and very fortunately does, participate in the proceedings which determine our lives. The extent to which it does this and the practical results of such interference depend upon the kind of thinking we are able to do at the critical moment.

Socrates believed that all men were governed wholly by what wisdom they had. When men do wrong, as they often do, it is because they know no better, he thought. He therefore argued that only by becoming wiser might men hope to become better. This rather startling teaching probably goes too far in its assertion of the controlling influence of the intellect in practical living. The contention of Socrates, nevertheless, helps us to see the truth, namely, that what thinking we do, good or bad, does have powerful influence on our conduct, although it may not be a controlling influence.

Whatever our natures, therefore, and wherever they may have come from, the success or failure of our attempts to satisfy them and to live the life we wish to live is to a large degree determined by our thinking.

A few examples of the part thinking takes in everyday life may be helpful. The normal human being is born with an impulse to play, and it influences him from the cradle to the grave. Play is action for its own sake, with no objective to be secured from it. In childhood play may consist of mere muscular activity. With advancing maturity, it grows more and more complex, but it never ceases to be aimless. When play is indulged in for

profit of any sort, it becomes work, and the player ceases to be an "amateur" and becomes a "professional." He may still be called a player, but he is in fact a worker. As play becomes more intricate, it demands more intelligence. Indeed, thinking may be an important factor in play. From kicking a ball about and running after it, as the child does, play goes on to such complex games as chess, which requires a minimum of physical exertion and a maximum of thinking. Between these two extremes lie all the other forms of play, all or almost all of them requiring thinking in some degree. And here, as elsewhere, honor is accorded to the factor of brains rather than brawn. Even the prize fighter claims to win his victory by science.

Thinking gives direction to instinctive efforts at acquiring wealth. There is everywhere a fierce rivalry between men for success in industrial and commercial fields. The time was when this rivalry was a matter of bodily strength; now the prizes go to those who are the best thinkers. Human relations have largely become a war of wits. The keenest, clearest minds are incessantly pushing themselves upward in the mass of economic society. This issue is so insistent just because it involves the most fundamental problem, that of the control of the necessary means of physical existence, the question of how to make a living.

One of the greatest of problems, and one that is never finally solved, is the successful organization of human society. In the old days this question was temporarily disposed of by the unresisting acceptance

of the principle of tyranny. To some individual was accorded the right to rule over all the others, and that without question or restriction. But it became evident that only a low form of society, made up of inferior individuals, could exist under such an organization. Since the tyrant was discarded much of the best thinking of the best thinkers has been engaged in the attempt to devise a form of society which will be a complete success. Politics, in a very large sense, has properly demanded a good share of the intelligence of the people. And it does not appear that this problem of government is soon to be so solved as to permit of its being supplanted by another problem.

One special phase of this problem of the organization of human society has presented itself in most imperative form in these latter days. This is the problem of peace and war. Under the tyrant, war was accepted as the normal condition of human society since the tyrant did not hesitate to use men as mere things in the attainment of his personal ambitions.

The terrible shocks that came out of the World War led men to think of this problem as never before. They wished if possible to avoid war's horrible consequences. How to secure safety without the cost of war is the problem of the age. No subject has enlisted the coöperative effort of the highest intelligence of men as this one is enlisting it now. Innumerable solutions for the question of war and peace have been suggested, but they all seem to disregard some of the inexorable facts. Yet all good men believe that a solution must be found. There is a sense in

which we now live in a new world politically. Men have transferred their loyalty from the autocrat to humanity, and they have substituted the virtue of intelligence for that of obedience. He now contributes most to human welfare who brings to it the highest wisdom. He who is most wise is the one who does the most successful thinking.

In the larger ranges of thinking, as means to practical ends, *professional thinking* appears. Division of labor has been carried into thinking. Innumerable professions, each with its own subject matter and its own specialized type of thinking, are necessary to minister to the life of the race as it is being lived now. This professional specialization in thinking must go on to degrees probably not now conceivable.

CHAPTER XVI

CONCLUSION

Throughout the foregoing pages it has been assumed that a knowledge of the facts and laws involved in the processes of thinking would aid those processes and enhance the reliability of their results.

The science of education—if such it may be called—teaches that a knowledge of the science which underlies an art will contribute to the successful practise of that art. If this be true and we start with it as our major premise and add, as our minor, that thinking is an art, we might seem permitted to draw the legitimate conclusion that a knowledge of the science of thinking would improve our practise of the art of thinking.

Reasoning analogically, it would seem that as a knowledge of the principles of athletic sports tends to increase skill in them, and as a knowledge of the technique involved is helpful to the musical artist, so a knowledge of the processes of thinking must assist in the effort to think successfully.

But the one thing that is beyond question, and one which can be established by a valid inductive argument, is that improvement of one's ability to do anything—think, for instance—will come, if at all, by careful, intelligent, prolonged practice. Not

mere practise, let it be remembered, for that might intensify the disposition to perform badly, but practise incessantly attended by the determination to improve, and guided by a knowledge of the facts and principles involved, and of the mistakes which so unremittingly threaten. In this way the knowledge obtainable from the actual study of thinking may be made certainly and permanently useful.

May the reader of these pages become a better thinker than he would have been had he not read them.

INDEX

INDEX

- A, E, I, O proposition, 68 ff.
- Abstract terms, 30.
- Accidental characteristics, 34.
- Adaptation, an aim of education, 2.
- Affirmative propositions, 61.
- Affirming the consequent, 223.
- Alternative propositions, 71 ff.
- Alternative syllogisms, 174 ff.
- Ambiguity of diction, 217.
of terms, 28.
- Analogical reasoning, 150 ff.
presuppositions in, 152.
- Analogy, definition of, 150.
- Analysis, 107, 119.
contrasted with synthesis, 109.
induction by, 159.
- Antecedent, 73, 177, 179.
- Antecedent cause, 116, 126.
- Antecedent, fallacy of denying,
223.
- Archimedes, 152.
- Argumentum ad baculum*, 219.
ad hominem, 219.
ad ignorantiam, 219.
ad populum, 219.
- Aristotle, 164, 165.
- Assuming the conclusion, 223.
- Axiomatic knowledge, 14.

- Bacon, 164, 165.
- Baconian method, 155.
- Begging the question, 223.

- Categorical propositions, 68 ff.
conversion of, 135.
inter-relation of, 142.
obversion of, 139.
- Categorical syllogism, 187.
figures of, 194.
moods of, 190.

- Causality, 111.
- Cause, 112.
antecedent, 116.
concomitant, 116.
definition of, 126.
kinds of, and conditions, 115.
- Cause and effect, 111.
means of determining, 119.
methods of determining, 125.
results of determining, 129.
- Changing the issue, 218.
- Character, an aim of education, 2.
- Characteristics, accidental, 34.
essential, 158, 159.
- Classification, 38 ff.
basis of division in, 40.
rules of division and, 42.
fallacies of, 220.
- Community of thinking, 93.
- Complete enumeration, 158.
- Conclusion, assuming the, 223.
- Conclusion, 161.
in dilemmas, 182.
in categorical syllogisms, 188.
in hypothetical syllogisms, 177.
- Concrete terms, 30.
- Conditions accompanying cause,
115.
- Connotation, 30, 33 ff, 36, 45.
- Concomitant variation, 127.
- Consequent, 73, 177, 179.
fallacy of affirming the, 223.
- Continuum, 113, 114, 128.
- Conversion of propositions, 135.
fallacies of, 221.
by limitation, 136.
simple, 136.
- Creative thinking, 92.
- Current report, 19, 94, 162.

- Darwin, 106, 121.
 Deduction, 155, 161.
 uses of, 165.
 forms of, 169 ff.
 Denotation, 30 ff.
 and definition, 45.
 and distribution of terms, 58.
 relation of, to connotation, 36 f.
 Denying the antecedent, 223.
 Descartes, 217.
 Differentia, 41, 45, 47.
 Definition, 45.
 fallacies of, 220.
 Dilemmas, 181.
 fallacies of, 226.
 types of, 183.
 Description, 46.
 Discussion, 85.
 Distribution of terms, 58 ff.
 and conversion, 135 ff.
 table of, 137.
 Diversity of purpose, 218.
 Division, 38 ff.
 fallacies of, 220.
 rules of, 42.

 Education, aims of, 1.
 salvation by, 1.
 Effects, 112, 113.
 Emotional disturbances, 212.
 Empirical laws, 130, 131.
 testing of, 168.
 Enthymemes, 169.
 kinds of, 170.
 Enumeration, induction by, 157.
 Essential characteristics, induction by, 158, 159 ff.
 Experiment, 122.
 conclusive, 124.
 Experimentation, 121 ff.
 difficulty of, 123.
 Explanation, 230.
 Euler Circles, 50, 69, 70, 72, 191.
 Events, 113.
 Evolution, theory of, 121.

 Facts, 7.
 knowledge of, 129.
 Fallacies of definition, 220.
 of the dilemma, 226.
 on division and classification, 220.
 Fallacious conversion, 221.
 Fallacy of more than three terms, 224.
 False analogy, 222.
 False cause, 222.
 Field of application, 54.
 Figures of the categorical syllogism, 194.

 Gambling, 203.
 Genus, 39.
 proximate, 45.
 Graphic presentation of the interrelation of categorical propositions, 145.

 Hasty induction, 221.
 Hegel, 216, 217.
 Hypothesis, 119.
 and laws of Nature, 120.
 and theory, 120.
 Hypothetical propositions, 73.
 Hypothetical syllogisms, 176, ff.
 rules governing, 179.
 Hume, 132.
 "Hunch," 21.
 Huxley, 211, 217.

 Ideas, 27.
 and judgments, 49.
 Illicit process of major term, 225.
 of minor term, 225.
 Imagination, required in observation, 104.
 in forming hypotheses, 121.
 Immediate inference, 134.
 types of, 135 ff.
 Incomplete disjunction, 224.
 Indefinite propositions, 66.
 Individual perception, 21.
 Induction, 154 ff.
 by enumeration, 157.
 by essential characteristics, 159.
 Induction and deduction compared, 163.
 Inference, 134.
 immediate, 134 ff.
 mediate, 150 ff.

- Inspiration, 21.
 Instinct, 239.
 Intellectual indifference, 210.
 Intellectual mendacity, 213.
 Intelligence, 10.
 Intelligent living, 238.
 Inter-relation of categorical propositions, 142.
 principles governing, 145.
 Intuition, 21.

 James, 17, 101.
 Judgments, 27, 49. (*See* Propositions).

 Kant, 132.
 Knowledge, an aim of education, 2.
 axiomatic, 14.
 nature of, 5 ff.
 sources of, 18 ff.
 types of, 11 ff.

 Langley, 124.
 League of Nations, 92.
 Logical principles, ignorance of, 214.
 Logical train of thought, 86.
 rules governing, 87 ff.
 Logical combination of judgments, 167 f.

 Major term, 188, 194, 225.
 Materials of thinking, 27.
 Mediate inference, 150.
 Memory and deductive reasoning, 167.
 Method of antecedent and consequent, 126.
 of concomitant variation, 127.
 of determining cause and effect, 125.
 Methods of thinking, 99 ff.
 Middle term, 187 f., 194.
 fallacy of, 225.
 Minor term, 188, 194, 225.
 Moods of categorical syllogisms, 190.

 Natural law, 120, 130.

 Nature, laws of, 120, 122, 130.
 uniformity of, 131.
 Negative propositions, 62.
Non sequitur, 228.
 Normal form of propositions, 51.
 reduction to, 76.

 Obscurity of diction, 216.
 Observation, 101 ff.
 aided by scientific instruments, 106.
 and cause and effect, 119.
 fallacy of, 221.
 prejudice corrupts, 105.
 Obversion of propositions, 139 ff.
 Opinion, 12.

 Partial propositions, 65.
 Pathology of thinking, 209 ff.
 Perception, 9.
 Preference and prejudice, 16.
 Personal coefficient, 213.
 Philosophy, 53, 154, 234.
 Plato, 57.
 Prediction, 236.
 Preference for accepted beliefs, 211.
 Prejudice, 16 ff.
 corrupts observation, 105.
 Premises, 150.
 in alternative syllogisms, 175.
 in categorical syllogisms, 188.
 in dilemmas, 182.
 in hypothetical syllogisms, 177.
 major, 161.
 minor, 161.
 Principle of consistency, 53.
 Principles, 8.
 of knowledge, 130.
 Probability, 199 ff.
 calculation of, 200.
 Problematic thinking, 91.
 Propositions—judgments, 49 f.
 alternative, 71.
 categorical, 68.
 distribution of terms of, 58.
 field of application of, 54.
 hypothetical, 73.
 indefinite, 66.
 normal form of, 51.

- quality of: affirmative, negative, 60 ff.
- quantity, of: universal, partial, 63 ff.
- reduction to normal form, 76 ff.
- singular, 64.
- truthfulness of, 52.
- Proved knowledge, 13.
- Quality of judgments and propositions, 60 ff.
- Quantity of judgments and propositions, 63 ff.

- Rationalization, 91.
- Reason, 23, 239.
- Reasoning, 23.
- Reflex action, 239.
- Results of determining cause and effect, 139 ff.
- of thinking, 230.
- Reverie, 90.
- Robinson, J. H., 90.

- Science, 232 ff, 244.
- Scientist, 11, 121, 233.
- Scientific instruments, 106.
- Sensation, 9.
- Socrates, 233, 234, 240.
- Species, 39 f.
- Stupidity, innate, 209.
- Suggestion, 12.
- Syllogisms, 172.
 - alternative, 174.
 - categorical, 187.
 - hypothetical, 176.
- Symbolic aids, 49.
- Synthesis, 108, 109, 119.

- Telepathy, 21.
- Terms, 27 ff.
 - abstract and concrete, 30.
- ambiguity of, 28
- connotation of, 33.
- definition of, 45.
- denotation of, 31.
- distributed, 58.
- division and classification of, 38.
- major and minor, 188.
- middle, 187 f.
- of propositions, 49.
- undistributed, 58.
- Testimony of others, 19 f.
- Theory, 120.
- Thinking, and education, 3 f.
 - community of, 93.
 - creative, 92.
 - pathology of, 209 ff.
 - results of, 230.
 - skill in, how attained, 244.
 - a source of knowledge, 22 ff.
- Tradition, 18, 132, 162.
- Trains of thought, 27.
- rules of logical, 87 ff.
- types of, 90 ff.
- Truthfulness of judgments and propositions, 52.

- Understanding, 230.
- Undistributed middle term, 225.
- Uniformity of Nature, 131.
- Universal propositions, 63 ff.

- Valid reasoning, 161.
- Valid moods of categorical syllogism, 194.
- Validity of hypothetical syllogisms, 177.
- of categorical syllogisms, 190.
- Verification, 168.

- Welton, 86.
- Wilson, 57.
- Wisdom of the Ancients, 132.

